THE EAST MIDLAND GEOGRAPHER

CONTENTS

No. 11. JUNE, 1959

THE DEVELOPMENT OF RURAL SETTLEMENT AROUND LINCOLN, WITH SPECIAL REFERENCE TO THE 18th AND 19th CENTURIES(1)

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INTRODUCTION

The study of rural settlement occupies a significant place in geographical literature and the relationship between settlement patterns on the one hand and physical, economic and social conditions on the other has long been recognised. In eastern England the pattern of rural settlement is composed basically of nucleated villages established in pre-Conquest times and of dispersed settlement made at a much later date, mainly in the last two hundred years. While the pattern of this settlement is generally well-known, the conditions under which it came into being are not so well appreciated. This paper has therefore been prepared as an attempt to assess and elucidate these conditions as they applied to an area of approximately fifteen miles radius around the City of Lincoln.

EARLY SETTLEMENT

Roman Lincoln was built on the northern side of a gap in the limestone escarpment which runs the length of the county from south to north (Fig. 1). On the western side of this Jurassic cuesta lies a vale composed principally of Liassic clays covered in places by large tracts of Pleistocene river gravels. To the east of Lincoln is another clay vale consisting mainly of Upper Jurassic clays, in the southern part of which these rocks are now partly buried beneath deposits of silt and peat which form the northernmost part of the Witham fens.

The Roman occupation made few lasting impressions on the countryside around Lincoln, except for two major roads and a canal, and the main outlines of the dominantly nucleated settlement pattern were established in the Anglo-Saxon and Scandinavian periods. Few villages were founded after the Conquest, for the great majority of present day villages are recorded in Domesday Book. Reliable plans for these villages are, however, uncommon for dates prior to 1700, but plans are available for a large number of villages between 1750 and 1850 and these show that the villages were then of a strongly nucleated character. The houses were frequently grouped along either one main street, or two parallel streets, while a second (back) street which contained few or no houses was another common variant.

The sites of these villages appear to have been chosen mainly with an eye to two main requirements, viz. a reliable water supply and proximity to land suitable for arable farming. The areas chosen for cultivation at that time were generally those with deep clay or heavy loam soils, although the settlements themselves were usually placed on

(1) This article is based largely on the writer's unpublished M.A. thesis, entitled *Population and Settlement in Kesteven, c.* 1775—*c.*1885, University of Nottingham, 1957 (1958). For an interpretation of township boundaries see D. R. Mills, "Regions of Kesteven devised for the purposes of agricultural history" in *Reports and Papers of the Lincs. Architectural and Archeological Society*, 7 (1), 1957, pp. 60-82.

an adjacent outcrop of a drier nature. For example, the settlements of the cuesta are situated on the limestone outcrop near its junctions with clay horizons, i.e. in the spring zones of both scarp and dip slopes. In the vales many villages occupy sites on gravels which yield a good supply of water because of the underlying layers of impervious clay. Other villages in the vales are to be found on the modest, but well-marked eminences which act as the water partings between minor streams.

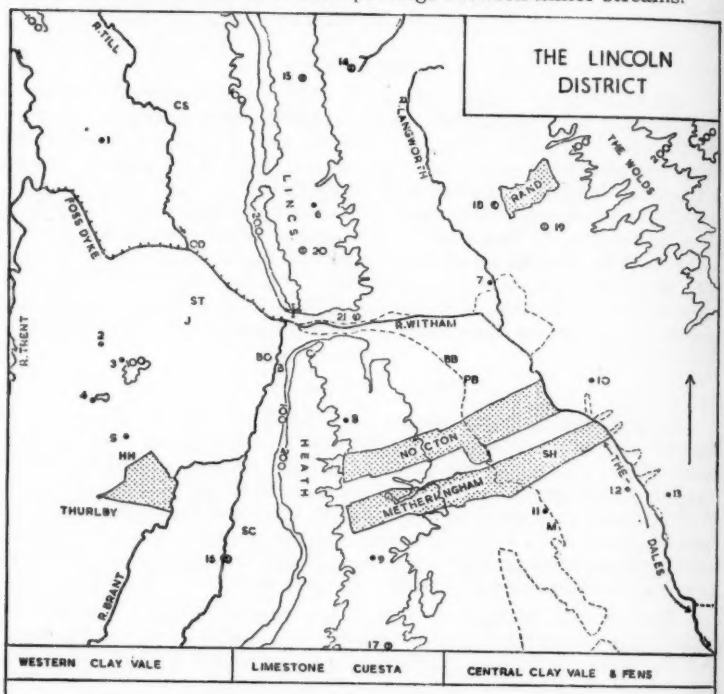

Fig. 1
The Lincoln District—Location Map.

A—Monastic settlements represented by dwellings at the present time :
1—Stow Park; 2—Swinethcrpe; 3—Eagle Woodhouse; 4—Eagle Hall; 5—Morton Hall; 6—Grange de Lings; 7—Low Barlings; 8—Mere Hall; 9—Temple Bruer; 10—Tupholme; 11—Linwood Hall; 12—Sim Booth Grange; 13—Kirkstead Abbey.

B—Settlements partly or wholly depopulated during the medieval period, now containing a few houses :
14—East Firsby; 15—West Firsby; 16—Skinnand; 17—Dunsby; 18—Bullington; 19—Goltho; 20—Riseholme; 21—Greetwell.

C—Contours at 100 ft. interval.

D—Limit of the Witham Fens.

E—Lincoln : position of first Roman Enclosure.

F—Areas of sample townships.

Other Places mentioned in text :
B—Bracebridge; BB—Branston Booths; BO—Boultham; C—Canwick; CS—Coates-by-Stow; HH—Halfway House Inn; J—Jerusalem; M—Martin; OD—Odder; PB — Potterhanworth Booths; SC — Somerton Castle; SH — Sot's Hole; ST — Skellingthorpe.

The availability of settlement sites appears to have largely determined the pattern of township boundaries, which is an important subject in relation to the later dispersal of settlement. There are, in fact, two characteristic township shapes; the long narrow townships attached to the villages of the spring zones and the townships of a more compact shape, sometimes almost square, which are found in the clay vales. (See Fig. 1 for examples of each type.) The shapes of the first type were largely due to the fact that suitable settlement sites could only be found in the narrow spring zones which run from south to north; flanking these zones lay the limestone heaths and the damp ground of the fens and the lowest areas of the clay vales. Land could therefore be freely taken in for several miles to east and west, while on the other hand settlements were hemmed in on the north and south by similar villages situated at intervals of about a mile—hence the gridiron pattern of long rectangular townships so common in scarpland England. Generally speaking this gridiron pattern is repeated in the clay vales around Lincoln, except that there the townships form rectangles which are much shorter in relation to their width. This pattern seems to be mainly a response to the rectilinear plan of the minor streams, for where the natural drainage network is more irregular, as in the gravel terrace country south west of Lincoln, the pattern of township boundaries also becomes more irregular.

Prior to the 18th century isolated dwellings appear to have been exceptional, but records do exist of various kinds of early dispersed settlement. In late medieval times both monastic houses and their granges were frequently erected at some distance from existing villages and many of them are still represented by isolated farmhouses, such as Eagle Hall and Grange de Lings (see Fig. 1, settlements numbered 1-13)(1). Most of these monastic settlements were situated in the less attractive areas of heath, fen and moor.

A second type of dispersed settlement sprang up on the banks of the River Witham and the Foss Dyke canal. There are, for example, several extant 16th century probate inventories of persons who had lived on the right bank of the Witham in the fens between Blankney fen and Billinghay fen, an area known as the "Dales." The occupation of waterman is sometimes recorded, but some of the inhabitants of the Dales may have been fowlers, fishermen or shepherds. A similar isolated dwelling near the Foss Dyke, called Odder, is recorded as early as 1509, while there are two isolated "Booths", whose recorded existence also begins in the 16th century, which are situated on the bank of the Car Dyke, a drainage channel of Roman origin. (Fig. 1)(2).

Among the settlements mentioned in Domesday Book there are some that have failed to survive to the present day, while others are represented by only one or two farms. These were originally small nucleated settlements, but they must now be regarded as dispersed settlement. This change in the form of settlement came about as a result

(1) Monastic orders were often given grants of demesne land which could be enclosed without undue complications (see *Victoria County History, County of Lincoln*, II, pp. 202-4, 206, 211, 212-3 and 239). Sites of monastic houses on Fig. 1 are based on *Victoria County History, County of Lincoln*, II; Mrs. F. L. Baker, *History of Riseholme*, 1956, pp. 18-20 and C. W. Foster and T. Longley, *The Lincolnshire Domesday*, Lincoln Record Society, Vol. 19, 1924, pp. xlvii-lxxii.

(2) Lincs. Archives Office: information for Odder from Hathey Account Book of Bishop's Possessions; for Branston Booths from inventory c.1566.

of the depopulations of the 14th-17th centuries, which also removed the "lost villages" entirely from the map of settlement. In some cases one factor which probably promoted the loss of population was the small size of a township and the fact that it contained only one major soil type. Thus Skinnand and Dunsby, for example, both contained less than 1,000 acres, while Skinnand was confined to the Witham clay vale and Dunsby to the limestone heath. On the other hand, some pre-Conquest settlements appear never to have grown to any substantial size and still contain so few houses that they barely deserve the title of hamlet; a good example is Coates-by-Stow which consists of a minute church, one farm and three or four cottages (Fig. 1)(1).

Sometimes purely local circumstances, which were not repeated within the district, led to the dispersal of settlement at an early date. For instance, the warrener's house on the Lord's Moor in Skellingthorpe is recorded as early as 1694 and there is evidence that Somerton Castle has been continuously occupied since the days of its military importance(2).

The Dispersal of Settlement since c.1750

Despite all these minor reasons for the scattering of settlement, many townships in the middle of the 18th century contained no dispersed settlement at all and nowhere is it likely that the dispersed population exceeded 5% of the total(3). Yet by 1851 the situation had radically changed and in a few townships nearly half the population was living outside the villages. Information for this date is derived from the original copies of the census returns, in which the enumerators were required to state the address of each household. Unfortunately many of the enumerators appear to have felt that the name of the township was a sufficient address; in other cases they have not indicated precise addresses very clearly. However, about one return in four is sufficiently accurate for present purposes and Table I has been based on the returns for those townships in the district to which this provision applies(4).

Other than the large increase in dispersed population, three salient facts emerge from Table I: firstly, the high averages of dispersed population (31·0% and 35·4%); secondly, the wide variations from these averages in individual townships; and thirdly, the similarity between the averages for the two main types of township, the average for the clay vale townships being slightly the larger. The last point is particularly significant in relation to the impression gained from a study of the Ordnance Survey Third Edition One-Inch Maps of 1883-88. The impression is that there was considerably more dispersed settlement in the spring zone townships than in the clay vale townships (cf. for example, Figs. 2 and 3). If it can be supposed that the census and the Third Edition Maps are equally reliable, it must be inferred that the dispersal of settlement continued to a later date in the spring-zone townships than in the clay vale townships. Unfortunately there is suitable information

(1) Nos. 14-21 on Fig. 1 are depopulated settlements based on Foster and Longley, loc. cit., and M. Beresford, *The Lost Villages of England*, 1954, pp. 361-4.

(2) Information on Coates and other villages north of Lincoln from D. R. Mills, *Settlement Patterns and Population in the Till Basin*, unpublished B.A. dissertation, University of Nottingham, 1952; LAO, LD 71/4 and T. M. Blagg, *Somerton Castle*, paper read to the Thoroton Society of Notts., 20 May 1933, p. 1.

(3) Based on A. Armstrong's One-Inch map of Lincs., 1776-78 and on many maps of individual townships.

(4) Public Record Office, HO 107/2104-6.

on this point for only one spring-zone township, Nocton, where the proportion of the population living in dispersed dwellings rose from 48·7% in 1851 to 52·5% in 1891 and 57% in 1901(1). Only further work over a larger area and upon enumerators' returns at later censuses as they become available will enable a more definite conclusion to be reached on this subject.

TABLE 1

PROPORTION OF POPULATION DISPERSED IN SELECTED TOWNSHIPS, 1851

(NOTE.—The hamlets mentioned are of medieval and not modern foundation.)

PART I. SPRING ZONE TOWNSHIPS.

Township.	*Population in Township, 1801*	*Population in Township, 1851*	*Population in Village, 1851*	*Population Dispersed, 1851*	*Population % Dispersed, 1851*
Cammeringham	111	141	79	62	43.8
Canwick	215	210	122	88	41.8
Coleby	301	423	339	84	19.8
Hackthorn	218	258	163	95	36.8
Harmston	235	414	357	57	13.7
Ingham	225	712	370	342	48.0
Nettleham	377	944	627	217	23.0
Nocton	287	510	266	Heath 99, Fen 150 } 249	48.7
Saxby	69	120	90	30	25.0
Spridlington	126	313	262	51	16.2
Welton	380	604	379		
		Rylands Hamlet	111 } 490	114	18.7
Totals and Average.	2,542	4,649	3,165	1,484	31.0

PART II. CLAY VALE TOWNSHIPS

Aubourn	179	304	219	85	27.6
Cherry Willingham	77	148	134	14	9.4
Doddington	140	175	103	72	41.1
Dunholme	140	411	297	114	27.7
Fiskerton	270	463	303	160	34.8
North Hykeham	254	443	304	139	31.4
Reepham	183	368	260	88	29.3
Saxilby	389	1,137	587		
		N. and S. Ingleby Hamlets	61 } 648	489	43.0
Skellingthorpe	193	584	297	287	49.1
Thorpe-on-the-Hill	190	379	256	123	32.7
Wickenby	119	289	172	94	36.0
Totals and Average.	2,134	4,700	3,035	1,665	35.4

Sources: Censuses 1801 and 1851, and enumerators' schedules 1851.

Generally speaking, dispersed settlement took the form of farmhouses, sometimes with cottages nearby, situated perhaps a quarter or half a mile from each other and frequently at some distance from a public road. Occasionally the houses are grouped loosely together, as at Jerusalem in Skellingthorpe. This settlement form is more frequently found in the fens where hamlets generally straggle along the bank of the River Witham or along a main drainage dyke, e.g. Martin Dales and Sot's Hole. It is in the narrow townships stretching for five to ten miles, partly across the cuesta and partly across fen or vale, that the dispersed settlement is most noticeable. For example, the western end of Metheringham township lies on the heath four miles away from the village. The heath had its own school for the children from the farms and cottages which straggle at intervals along or near the lane which leads down to the village. On the eastern side of the village the pattern

(1) Information for 1891 and 1901 from H. Green, *Lincolnshire Town and Village Life*, Lincoln Public Library, 1901-04, p. 23.

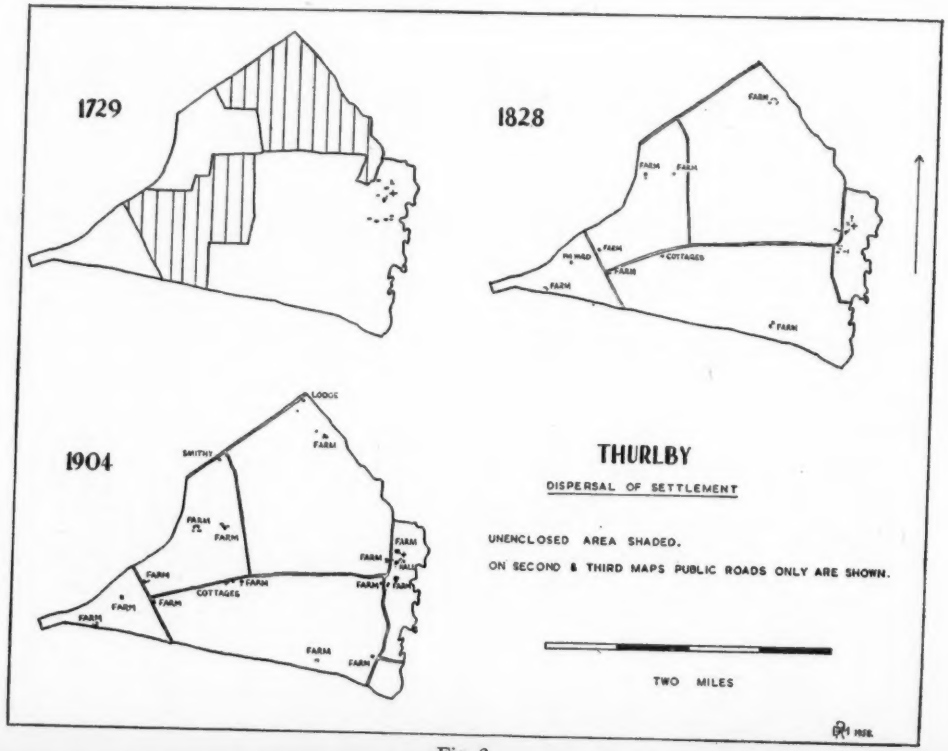

Fig. 2

Thurlby, a clay vale parish, 1729, 1828 and 1904. Information for two earlier dates kindly given by Sir Benjamin Bromhead, Bart., of Thurlby Hall.

is repeated for another five miles as the road continues first across a clay upland and then across the fen to the River Witham. In Metheringham fen there are two hamlets known as Sot's Hole and Tanvats, names which are rather quaint, yet typical of these 19th century settlements; their size and their isolation from Metheringham village warranted their being given a school and, at a later date, a bus service of their own.

This type of dispersed settlement has sometimes been regarded as a result of Parliamentary enclosure(1). Although it is true that very large tracts of land in central Lincolnshire, especially on the heath and in the fens, were enclosed by this method between 1765 and 1820, it is equally clear that the enclosure of land was not the only factor responsible for the large scale dispersal of settlement. Thus in the townships which were enclosed before 1750 the dispersal of settlement occurred no earlier than in townships where enclosure was not completed until the passing of an enclosure Act sometime between 1765 and 1850. (Fig. 2 shows a township in which enclosure was completed without an Act.) The enclosure movement was, in fact, only one aspect of the "agricultural revolution", which must be considered in some detail in order to understand fully the need for a dispersal of settlement at this time.

The Effects of the Agricultural Revolution(2)

During the fifty years or so beginning about 1765 considerable changes took place in the agricultural methods employed in Lincolnshire, as in many other parts of the country. Drainage improvements were particularly important in the fens where they made possible the conversion of meadow and pasture to arable; they also made it possible to build farmhouses and cottages over a much wider area of fenland and the banks of the new drainage dykes were favourite sites for new roads and buildings. The adoption of the Norfolk rotation of barley, seeds, wheat and turnips made possible the cultivation of the light soil areas of heath and moor, thereby again turning grassland into arable land. Since the reclaimed areas of heath, fen and moor usually lay at the extremities of townships, their use as arable land doubtless prompted the erection of farmhouses and cottages within them.

In general, the agricultural revolution made farming operations more intensive and more complicated, especially during the winter months. For example, hedging and ditching now occupied farm workers for a large part of the winter. Most important were the increased numbers of cattle and sheep which were kept throughout this season. Sheep were kept partly for the sake of their manure and therefore spent the winter "folded" in the turnip fields. Another method of manuring the soil was the application of cattle and horse dung which accumulated in the covered accommodation of the farmsteads during the winter. The carting of dung and daily visits to sheep folds clearly made it very desirable to erect the farm buildings and dwellings amongst the fields belonging to the farm.

In addition to new farming activities, there were many age-old operations which could be carried out more conveniently from farmsteads situated in the fields. One important example was the carrying home of

(1) A. Demangeon, *Problèmes de Géographie Humaine*, Paris, 1952, pp. 199-200.

(2) Major sources of information for this section are: Joan Thirsk, *English Peasant Farming, the agrarian history of Lincolnshire from Tudor to recent times*, 1957; T. Stone, *General View of the Agriculture of Lincolnshire*, 1794; D. R. Mills, "Enclosure in Kesteven", *Agricultural History Review*, Vol. VII, Part II, Sept. 1959, in press.

Thurlby, a clay vale parish, 1729, 1828 and 1904. Information for two earlier dates kindly given by Sir Benjamin Bromhead, Bart., of Thurlby Hall.

the corn harvest, for until the middle of the 19th century threshing was still carried out by the use of flails on a barn floor. Even when machine threshing was introduced it was generally more convenient to carry out the operation in a farmyard than in a field, since water had to be supplied to the engine in large quantities and storage space found for the grain.

Apart from the years 1815-1840, agriculture was a prosperous business from the mid-18th century until the Great Depression of the 1870's and 1880's. Capital was therefore available for improvements, many of which had possibly been obvious to farmers for a long time, but had not been carried out for lack of money. Moreover, a new spirit of efficiency entered farming in the third quarter of the 18th century and the new farmsteads in the fields were spacious and well-made and generally contained a "crew-yard", a partly covered yard in which cattle and horses spent the worst parts of the winter. The amount of space required by these new steadings may in itself have been a factor dictating construction in the fields, rather than in the relatively built-up areas of the villages, where however some farmsteads of the new type are to be found.

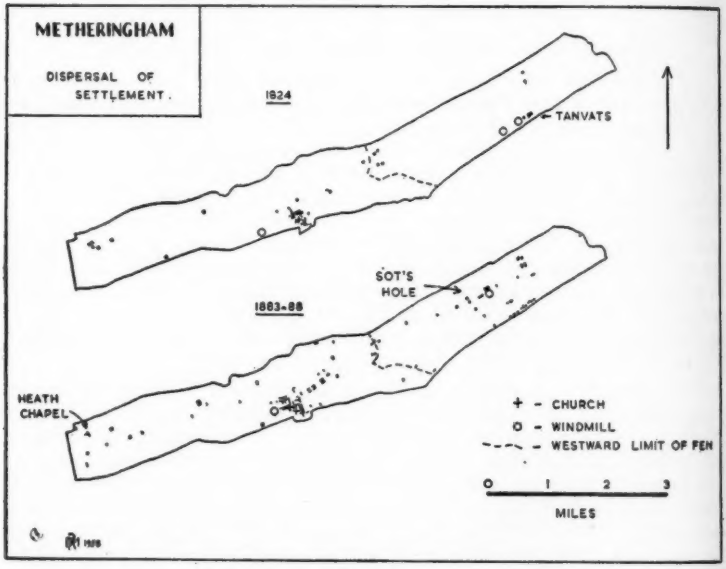

Fig. 3

Metheringham, a heath and fen parish, 1824 and 1883-88. The award map of 1779 shows no settlement outside the village ; a drainage map shows that three farms had been built in the fen by 1793.

Despite the inflow of money and ideas, the dispersal of settlement was clearly a gradual rather than a sudden process, for in most townships there were far fewer dispersed buildings shown by the First Edition of the Ordnance Survey in 1824 than by the Third Edition in the 1880's. (See Figs. 2 and 3 for examples.) One of the causes of the relative slowness of dispersal may have been the fact that although money was more easily found for investment in farming, there were many other calls on capital resources, such as enclosure, drainage and fencing.

Another cause may have been the difficulty of re-arranging farm boundaries satisfactorily. In the days of open-field farming, the village had been the nodal, if not the central point of most farms, since each of them held land and common rights scattered throughout the township. In principle, enclosure was followed by the creation of compact holdings, thereby reducing the effective nodality of the village. However, in practice, enclosure commissioners in Lincolnshire frequently gave owners several blocks of land in different parts of a township,(1) so that several years or decades may have elapsed before the more or less compact holdings of today were the general rule. Only when the fields of each farm were grouped together was there any point in building new farmsteads outside the villages.

The overall effect of the many changes in farming methods was a vast increase in the demand for labour, especially in those areas where grassland had been ploughed up in large quantities. Only in the 1840's was labour saving machinery of any importance brought into operation on farms; in the meantime many time consuming tasks had been introduced into the farm calendar. Consequently there were large increases in population in rural Lincolnshire from about 1770 until about the middle of the 19th century and in many townships the population doubled between 1801 and 1851 or 1861 (see Table 1). The need for extra living accommodation was therefore very considerable and since few of the villages expanded by more than about one-third in the size of built-up area, a large proportion of the population increases must have been housed in the new dispersed dwellings. In fact, had there been no substantial increases in population the dispersion of settlement might not have reached its present proportions.

Other Reasons for the Dispersal of Settlement

In addition to the changes in agriculture, there were other minor factors which promoted the dispersal of settlement after about 1750. These included the turnpikes and the railways which respectively necessitated the construction of toll houses and crossing keepers' cottages and stations. Inns, too, were sometimes built in isolated positions, generally on main roads where they could cater for passing travellers. A good example is the Halfway House Inn in Swinderby parish which lies on the Fosse Way seven miles from both Lincoln and Newark. In townships where there was a resident landed family, lodges were often built either on the boundaries of the township or at the entrances to the park and were no doubt largely the result of Romantic ideas of landscape gardening. In connection with farming, many windmills were erected, either for milling corn or for drainage purposes and many of them had houses attached.

In the main however the dispersed settlements were, and still are occupied by families whose livelihood comes directly from the land and many of the houses are "tied cottages". In fact, the tied cottage system appears to have evolved largely out of a desire to house rural workers as near as possible to the place of their work. On the other hand most of the families engaged in the various service trades and in building continued to live in the villages, which for their purposes remained the most convenient places of business.

(1) One commissioner complained vociferously about this practice on the grounds of inefficiency (Stone, op. cit., p. 43). Unfortunately enclosure awards seldom give information about the actual occupation of land.

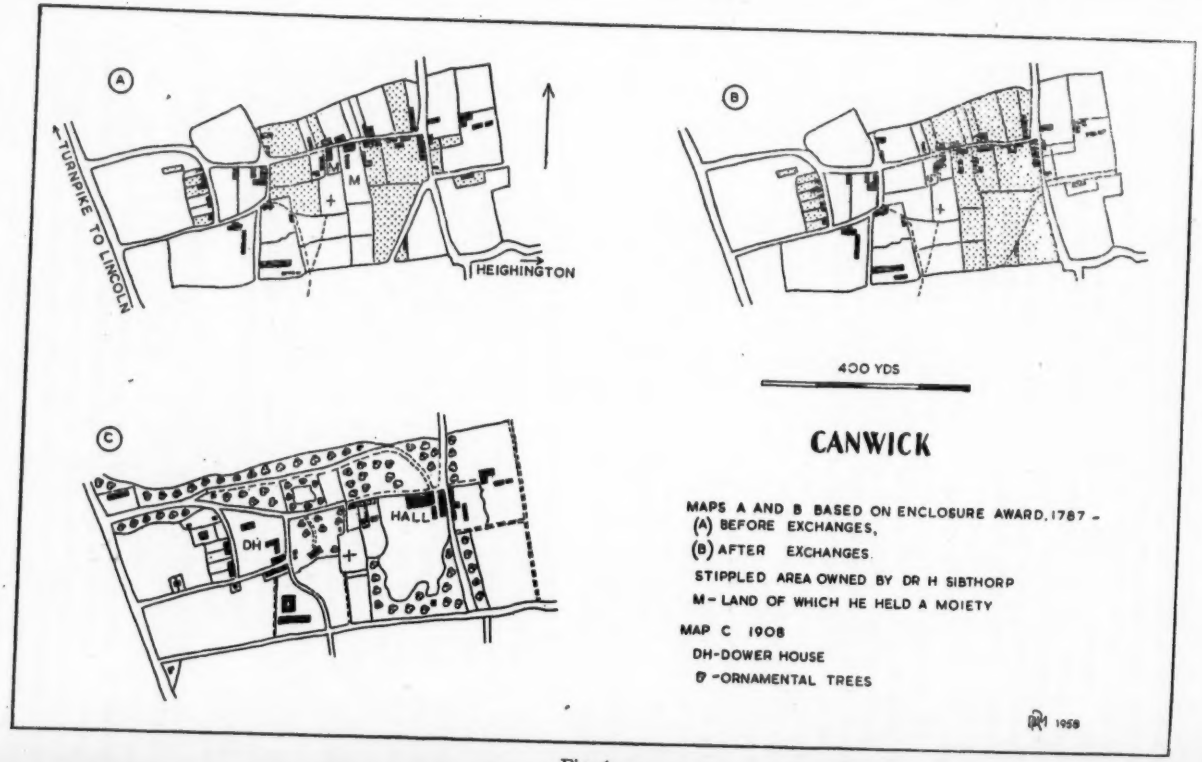

Fig. 4
Canwick—1787 and 1908 ; changes due to Sibthorp influence.

Changes in the Grouped Settlements

Despite the great increases in dispersed settlement Table I shows quite clearly that these did not absorb the whole of the increase in population in every township. Two other possible explanations must therefore be considered : firstly, that owing to an increase in the size of families there was a smaller number of households per unit number of the population and consequently a smaller demand for extra houses than might otherwise have been the case : and secondly that the rebuilding of villages provided an opportunity to build more houses on the same amount of ground.

Evidence concerning the latter point is difficult to assess. There is no doubt that a great deal of rebuilding was done, for the great majority of houses built before the First World War in Lincolnshire villages betray, by their building styles, that they were constructed in the 18th and 19th centuries. Moreover, in many villages a sizeable proportion of the smaller houses have been built in terraces of about four to ten dwellings. However, a study of village plans and of One-Inch Maps shows that the extent of the built-up areas of villages did not increase by more than modest amounts (Figs. 2, 3 and 4). This cartographical evidence does not, however, indicate which buildings were dwellings or how many separate dwellings there were in each building. It is impossible, therefore, to assess with any precision how much of the increase in population was absorbed by the old nucleated settlements and in what manner it was so absorbed. But the major argument stands that the increase in population was one factor promoting the dispersal of settlement.

Judged by their appearance today, and to a certain extent by their size, there are two characteristic types of grouped settlements : the estate village and the freeholders' village. Most of the houses in an estate village were built by the landed family who resided there ; they are therefore frequently of similar design and appear to have been built on a pre-conceived plan. The squire's home, generally known as the Hall, lies a little way off, secluded in its park, surrounded by lawns and gardens and therefore safe from the public gaze. The village itself has been made more beautiful by the planting of trees, shrubs and hedges, many of them of evergreen habit. In short, the estate village was a 19th century rural version of the "select quarter".

Two examples will suffice to illustrate this type of village a little further, especially in regard to the large scale changes which were sometimes carried out by gentlemen resident in the country. For instance, at Nocton, the church was rebuilt in 1775 because the old one "stood in inconvenient proximity to the hall"(1). Although the church remained untouched at Canwick, even more widespread changes were carried out by the Sibthorps (Fig. 4). This family had bought a "capital mansion house" there in 1730(2) and in 1787 it was able to acquire a more compact block of land owing to the exchanges of plots and closes which took place at the time of the enclosure award. At a later date the Sibthorps bought most of the remaining old enclosures. In the last years of the 18th century a much larger mansion house was built and extensive

(1) K. Norgate and M. H. Footman, "Some notes for a history of Nocton". *Reports and Papers of the Associated Archeological Societies*, 24 (II), 1897-98, p. 368,

(2) W. E. Madison, *The Sibthorpe Family*, 1896, p. 27.

grounds, a park and walled gardens were laid out. For this reason a public road from Heighington to Lincoln was diverted to the south and a row of cottages along this road was pulled down. Only in the 1950's has the road been re-opened to the public and detached villas built on the sites of former dwellings.

The second type of village, that belonging to a large number of small owners, was of a quite different character. It was generally much larger and the density of population in the township was much higher than the average for the district (for example, Metheringham and Martin), whereas the population density was almost always well below average in a squire's township. This difference was largely due, not to variations in soil or husbandry, but mainly to the differential operation of the Poor Laws. Up to about 1860 each parish or township had to maintain its own poor by means of a parish poor rate and it was therefore to the advantage of landowners and occupiers to restrict the working population and thereby reduce the numbers of potentially destitute persons. This restriction was most effective where a squire owned all or most of the land in a township and had control over the building of cottages. It was least effective where there was a large number of owners and occupiers, forming a large leaderless vestry which was unable or unwilling to discourage the building of cottages for "poor" people.

Amongst the freeholders in such a township were many tradesmen, such as blacksmiths and saddlers, and shopkeepers such as grocers and beer retailers. Occupations of this kind were much less well represented in estate villages, partly because there was a smaller population and therefore less trade, but also, no doubt, because it was the policy of controlling landlords to limit the number of tenancies given to tradesmen who needed their own labourers and assistants, persons always potentially dependent on poor relief. Another important factor was that tradesmen and shopkeepers appear to have sprung in many cases from the ranks of the yeomen, or small landowning farmers. Thus, in many freeholders' villages the 1851 Census and nineteenth century directories reveal the presence of men who were, for example, "publican, carrier and farmer of 30 acres" or "tea dealer, agricultural merchant and farmer of 140 acres." Such self-made men were noticeably absent from the estate villages where there was little opportunity to own small amounts of land, those precious assets of the small entrepreneurs.

The freeholders' village, therefore, was larger than the average, it contained many small workshops and business premises and owing to its piecemeal development its streets were full of houses built in a variety of styles (and sometimes of materials) and frequently arranged in the most haphazard manner. Here and there would be a rather larger house, but seldom the great house of a landed family ; absent were the cypress trees and yew bushes and flowering shrubs, and the overall effect was that of the workaday world.

While at either extreme the estate village and freeholders' village stood in great contrast to each other, there were also many villages which represented a compromise between the two dominant elements of rural society. In some cases most of the land was owned by an absentee landlord, or a corporate body such as Christ's Hospital, London, who were lords of the manor at Skellingthorpe. Here the farm tenancies were generally very large ones, but the absence of a great house and

family allowed the inhabitants much greater freedom in parochial affairs. In other cases the land was owned by a few substantial families who appear to have adopted a "middle of the road" attitude to the question of poor relief. Today, as in the 19th century, one may therefore encounter a great variety in the outward appearances and in the social structures of villages in central Lincolnshire.

More recently, since the First World War, another element has entered rural society, i.e., the overspill of urban population from Lincoln. Alongside the 18th and 19th century houses of redbrick or stone, there are many villas of the suburban type in those villages which are conveniently near the City, and two former villages, Boultham and Bracebridge have been enclosed within the City boundary by the extensions of the early twentieth century. In villages further afield, however, modern dwellings appear mainly as replacements for older ones no longer fit for habitation. But despite the changes of the twentieth century, including the decay of the landowning class, it is still possible to distinguish in the field the mixture of settlement types which the changes of the 18th and 19th centuries brought about.

CEMENTED SCREES IN THE MANIFOLD VALLEY, NORTH STAFFORDSHIRE

J. E. PRENTICE[1] AND P. G. MORRIS[2]

Deposits of broken fragments, more or less cemented, have been described from the Arctic regions (Cailleux 1948) and the Jura Mountains (Judson 1949). They have been termed *éboulis ordonnées* by the first author, and *'congelifractates'* by Bryan (1946). Judson has referred to them as *'rock-fragment accumulations'*, but this term does not indicate their characteristic cemented nature. The present examples are found in the deeply incised valley of the River Manifold, where it flows through the Carboniferous Limestone. They were observed by the senior author during his survey of the solid geology of the region ; the junior author has contributed additional and more recent observations.

The deposits occur on the valley sides extending from near the present river level up to 150 feet above it. Whilst small deposits have been noted in various parts of the valley between Ecton and Beeston Tor, the major occurrence is that below the village of Ecton (Locality 1, see Fig. 1). Here a quarry for road metal has been opened in the deposit, so that its structure and characteristics can be readily observed. A total thickness of 80 feet is exposed ; at the back of the quarry the bed-rock is exposed, consisting of limestones and shales dipping gently into the hillside. The rock surface below the scree appears steep and cliff-like, probably rising in a series of steps ; the congelifractate is banked up against this steep face. The deposit itself is rudely stratified, with alternate layers of harder and softer material. The hard bands consist of very angular fragments of limestone, ranging in size from 30 cms. down to 2 cms. diameter, the majority being in the 3/4 cms. size range. Cementation is by stalactitic calcite ; each fragment is coated with a thin veneer of dark calcite, and adheres to the next only by cementation at its points of contact. The deposit thus has an 'openwork' texture which appears to be characteristic of this form of deposit (Judson 1949 Plate I). Within the hard bands the fragments are only very roughly aligned, and in places no alignment can be discerned. The hard bands are from one to six feet in thickness ; between them are beds of softer material. These soft beds consist of smaller fragments (1 — 4 cms. diameter mainly) which are less angular than those in the hard bands, and which sometimes show signs of solution. The spaces between the fragments are filled with a soft reddish-brown clay, and stalactitic calcite appears to be absent. The alternation of hard and soft bands is repeated some eight times in the exposed face ; the boundaries between the bands are not sharply defined.

There can be no doubt that this deposit is an ancient scree, cemented by the action of percolating water. It is evident that the processes which formed it are no longer active in the area. No scree is forming in this situation today, and the relatively gentle (25°) slopes above are completely grassed over. In fact screes are forming in the Manifold Valley

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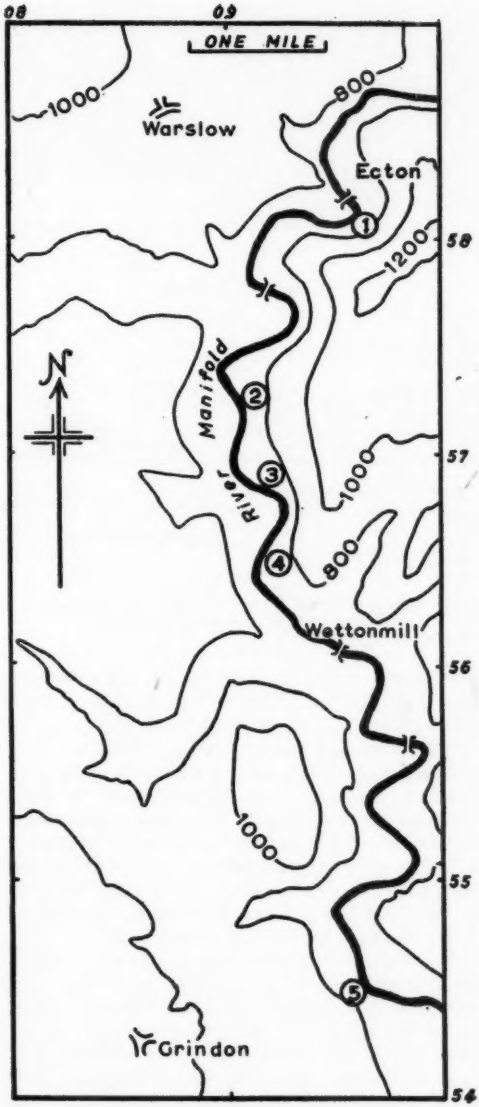

Fig. 1

Map of the Manifold Valley, North Staffordshire, to show location of occurrence of cemented scree (numbers in circles referred to in text). Contours in feet above Ordnance Datum; numbers at margin are those of U.K. National Grid.

today only below much steeper slopes (50° or more), as for example, below Thor's Cave and Beeston Tor. Thus the congelifractate cannot belong to the present phase of erosion ; in fact the plane of the present valley sides cuts across it, the 30° dip of the stratification being truncated by an erosion plane at 25°. The extension of the cemented scree down to a level near to that of the present river bed shows that the valley floor is still at essentially the same level today as it was prior to the formation of the scree ; whilst the slopes above the deposit must have suffered intense degradation. This would be best explained if the congelifractate had in fact completely filled the valley, so that the role of the river would have been largely one of re-excavation.

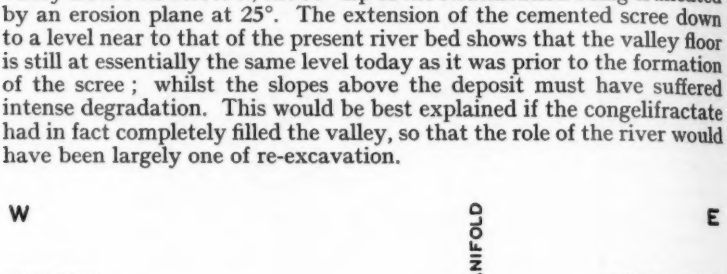

Fig. 2
Diagrammatic section across the Manifold Valley at locality 1. Structure in Carboniferous Limestone schematic.

The modern screes of the Manifold valley show no sign of secondary cementation on their surface. The extensive tips of the Ecton Copper Mine have been partly quarried away, but even in depth show no accretion of calcite, although they must have been in place for a century at least. The valley sides grade evenly to the present level of the river, and truncate solid rock and congelifractate to an equal degree ; a circumstance which clearly points to considerable antiquity for the cementation of the latter. Thus the cementation process appears not to to be as active today as in the past. Precipitation of calcite is accelerated by rise in temperature or by freezing, and as the fragments are of the form normally associated with frost-shattering, the latter circumstance seems to be more likely. Even so it seems unlikely that precipitation would occur unless the rapid run-through of meteoric waters was somehow inhibited. In this respect a mechanism suggested by Hollingworth (1950 p. 16), whereby the valleyward flow of ground-water is sealed off by the freezing of the upper 10—15 feet of ground, may be important. The stratification of the deposit into hard and soft bands is probably the result of climatic variation. It is suggested that the 'hard bands' were accumulated by mechanical shattering during the period of most intense frost ; whilst amelioration of climatic conditions allowed some chemical weathering, with the production of the reddish-clay residuum, to take place, with the consequent accumulation of the 'soft bands'. The soft bands, being relatively impermeable would tend to be less affected by the cementation process ; moreover the separation of

the fragments by clay in these bands would make them less likely to yield a welded aggregate.

It is noteworthy that the congelifracts consist entirely of local limestone material; no erratic rock of any kind has been found. It has been observed (Prentice 1951 Plate XV) that the main boulder-clay is found only on the western side of the Manifold valley, although scattered erratics and thin drift have been recorded further east (Jowett and Charlesworth 1929, p. 312 *et seq.*). These authors place the limit of the newer drift much further west; it is clear from the absence of erratics in the scree that the region was virtually stripped of boulder-clay before the congelifractate began to form. Thus it might well be contemporary with the formation of the Newer Drift of the Cheshire plain.

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POPULATION OF NORTHAMPTON AND THE ISE VALLEY, 1801—1951

C. D. MORLEY

The population growth of Northamptonshire since the first census of 1801 has been dominated by the development of the county town, Northampton, and a group of towns situated in the valley of the River Ise. A comparison of the density maps for 1801 and 1951 (Figs. 1 and 2) shows that while the agricultural parishes of the county either remained static or declined in population, Northampton and the towns of the Ise valley greatly increased. Northampton's share of the county's population rose from 6% to 29% during the 150 years, while that of the Ise valley rose from 6% to 26%.

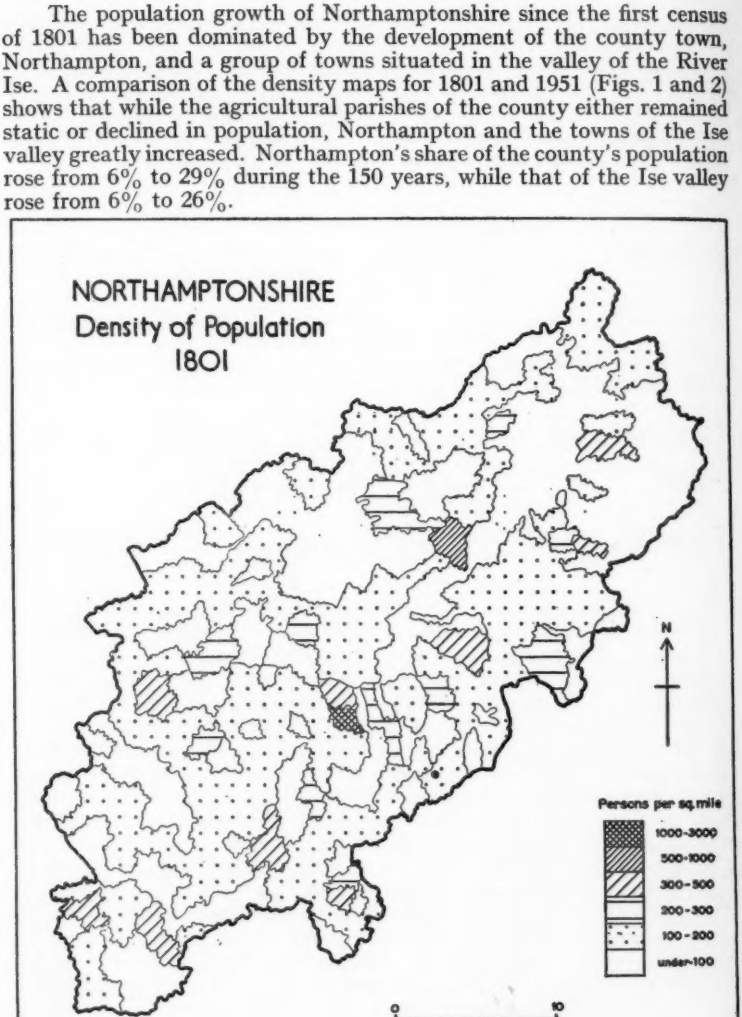

Fig. 1

The 1801 census showed a number of settlements which, by reason of their functional and occupational background, may be classed as urban. Of these, Northampton, situated at a point where a south flowing

tributary joins the Nene, was already dominant. With 90% of its families engaged in "Trade, manufacturing and handicraft"(1), it had developed both as a regional centre, due mainly to its site as a natural focus of routes, and as a centre for the growing boot and shoe industry. The River Ise is a major north bank tributary of the Nene. It rises in Sulby parish and flows first east then south to join the Nene immediately south of Wellingborough. In 1801 the Ise valley settlements included Kettering, Rothwell and Wellingborough, and the industrial villages of Desborough, Burton Latimer and Finedon. Wellingborough has a site very similar to Northampton's, for it overlooks the confluence of the rivers Ise and Nene at a point where a north-south route along the Ise valley crosses the east-west Nene valley route. Kettering stands on a ridge between the Ise and the Slade Brook, at a point where routes from the north-west and north-east converge on the Ise valley.

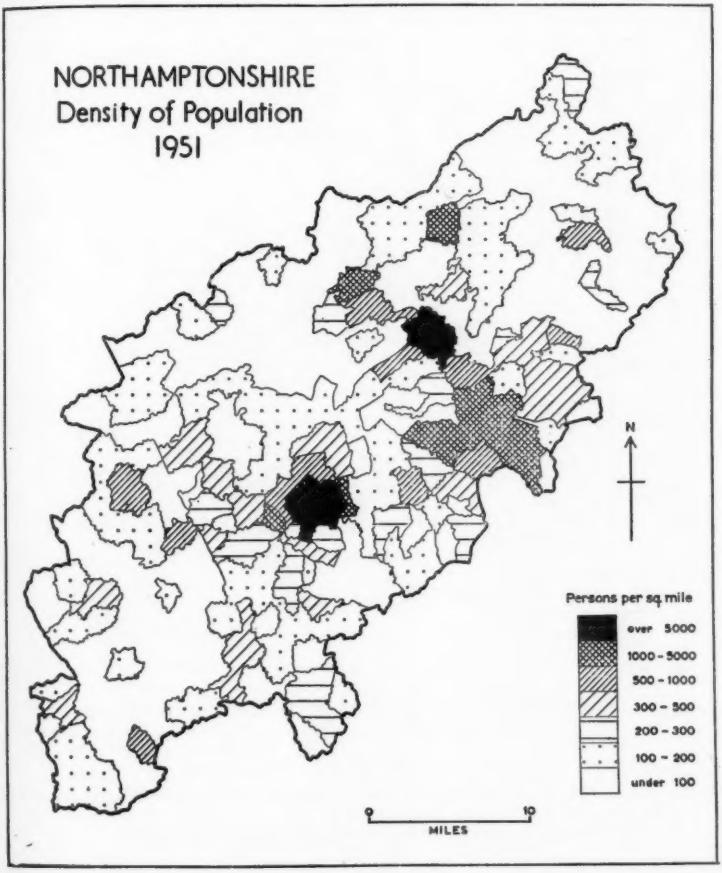

Fig. 2

(1) Abstract of Answers and Returns—Part I, 1801 Census.

Closely associated with the lower Ise valley settlements are those of the middle Nene valley, the market town of Higham Ferrers, and the industrial villages of Earls Barton, Rushden, Irthlingborough and Raunds. These are situated on dry point sites at various distances from the marshy Nene valley floor, and are closely linked to the Ise valley by communications. The term industrial village is used to describe a number of settlements of between 750 and 1,000 inhabitants in which more than 50% of the occupied population were engaged in non-agricultural pursuits, but which cannot be classed as towns owing to lack of urban functions.

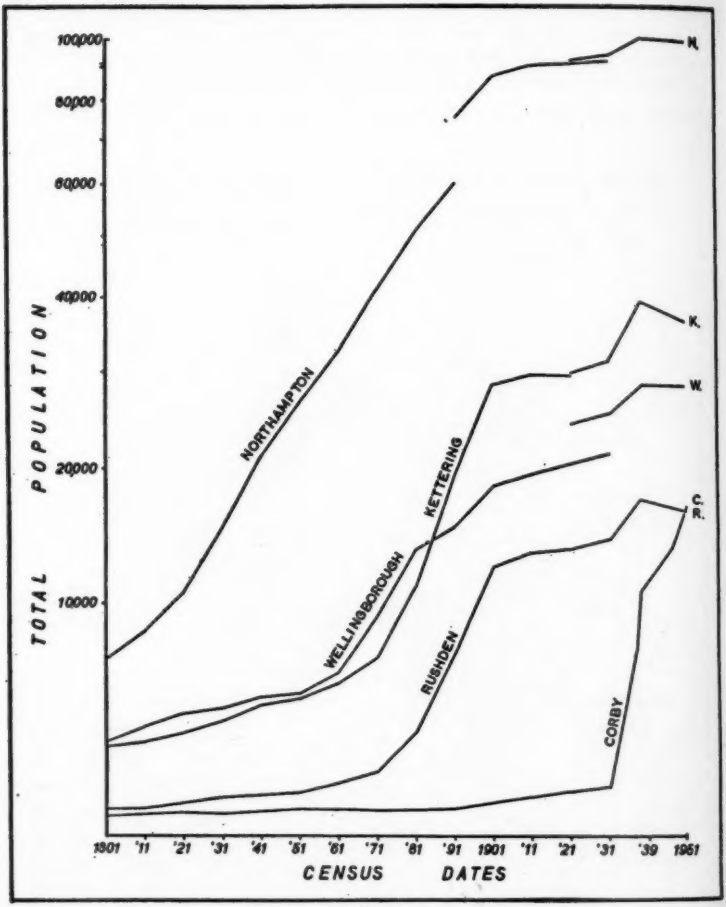

Fig. 3
Northants, main centres population change 1801 to 1951

Broadly speaking the population changes in Northampton and the Ise valley for the period 1801-1951 can be divided into four parts (Fig. 3). The period from 1801 to 1861 was dominated by the growth of Northampton. Between 1861 and 1901 Northampton's growth slackened

while that of the Ise valley increased. From 1901 to 1931 both areas stagnated but between 1931 and 1951 a gradual revival of population growth occurred likewise in both areas.

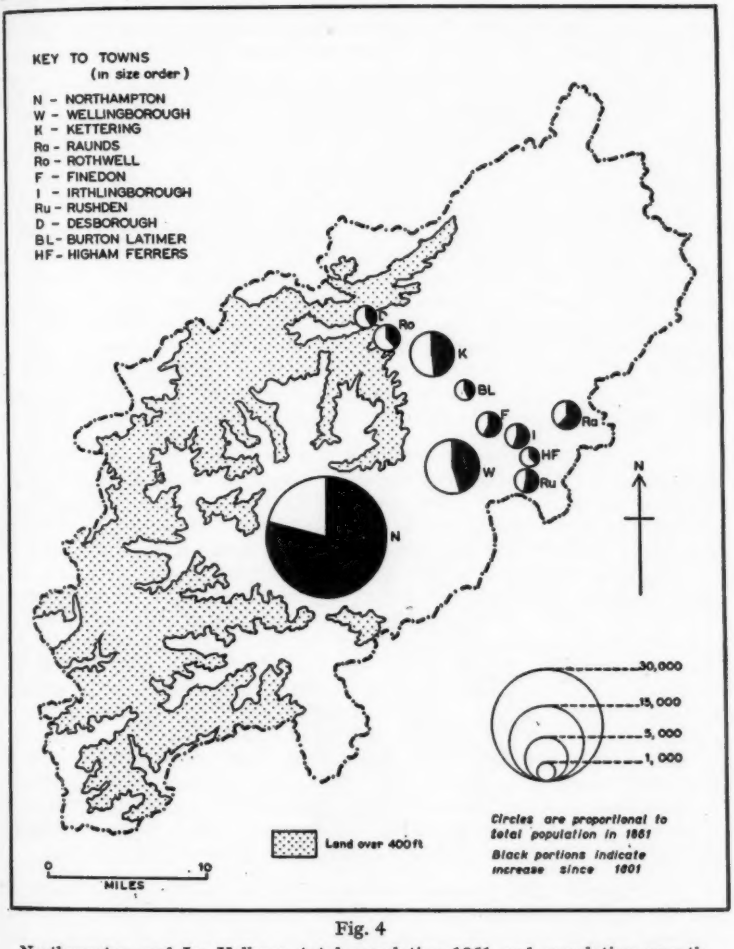

Fig. 4

Northampton and Ise Valley: total population 1861 and population growth 1801 to 1861.

During the first period Northampton completely dominated the pattern of population change in the county (Fig. 4). From 1801-41 the town trebled in numbers and the greatest rates of in-movement were recorded. This correlates with a phase in the county's population development when low rates of net out-movement were recorded and this rapid early growth may thus be ascribed in part to the lack of long distance transport facilities, which channelled the rural surplus to the county town (approximately 10,000 in the 40 years, while the net loss experienced by the whole county, including Northampton, was 14,000

persons). The influx into the town was particularly marked between 1821 and 1841 ; in 1831 one-third of the town's inhabitants had entered during the previous ten years. In 1841 23 % of Northampton's inhabitants had been born outside the county ; practically one-sixth of all outsiders in the county. The attraction of these large numbers can be directly related to the growth of boot and shoe manufacture in the town.

The building of the London-Birmingham Railway in 1838 was accompanied by a decline in the attractive power of the county town. Owing to construction difficulties the railway by-passed Northampton, although a branch line was built linking it to the main line in 1842. The effect was to enable surplus rural labour to leave the county, and the proportion entering Northampton declined. It is however important to realise that it was not until 1881 that any permanent decline occurred in the numbers entering the town, the decline was merely relative. A further factor partially responsible for this change is the growth of several of the parishes around Northampton. A census note in the 1821 volume mentions that the town was beginning to spread into the parishes of Hardingstone, immediately south of Northampton, and of Duston and Dallington to the west, while Moulton and Kingsthorpe to the north also began to receive immigrants around 1851. The town was thus already beginning to outgrow the limits of the borough boundaries.

During the period 1801 to 1861 the Ise valley does not stand out from the rest of the county to the same extent as Northampton (Fig. 4). Wellingborough, and to a lesser extent Kettering, did experience small rates of net in-movement during the first 50 years of the century, but on the whole, growth was not rapid (Fig. 3). These early years mark the development of the staple boot and shoe industry of the Ise valley, but on a domestic basis without requiring any large influx of population. In 1821 a census note records that "Wellingborough increased in population due to the large number of journeyman-shoemakers and their families who reside here ; the manufacture of shoes being the principal trade of the town". Also in 1821 Burton Latimer is recorded as being engaged in silk manufacture, the decline of which accounts for its drop in population after this date. However in the same year 1,805 of Kettering's population (that is nearly half) were paupers. Thus prosperity was not the general rule, due mainly to the continued reliance of the towns on their functions as markets for the surrounding agricultural areas. Generally speaking the southern area, around Wellingborough, increased at a greater rate than the more northerly area.

The decade 1851-61 marks the beginning of the period of influx into the Ise valley. It was not on the same scale as in later years, and was confined to the southern towns, especially to Wellingborough, but also to Rushden, Finedon, Higham Ferrers, and Irthlingborough. The reasons for this in-movement seem to be the accelerated growth of the shoe trade and the growth of ironstone quarrying and smelting in the area.(1)

During the second period of population growth, 1861-1901 (Fig. 5), Northampton experienced mixed conditions. After 1861 the slight drop,

(1) The census volume for 1861 includes several notes giving indications of this fact : "Increase in population at Finedon due to an extension of the shoe industry", "Increase in population in Wellingborough due to the establishment of ironstone furnaces and an extension of boot manufacture".

already mentioned, occurred in the rate of influx into the town. By 1871 movement into the town began to increase once more, and with a boom in the shoe trade, reached a peak of numbers entering (over 4,000) in the decade 1871-81. The adjoining parishes too were all markedly gaining population by in-movement during the period. However, between 1881 and 1901 the numbers entering Northampton dropped sharply, although numbers in the surrounding parishes continued to rise. Between 1895 and 1900 the borough of Northampton was extended to cover parts of the parishes of Hardingstone, Duston, Dallington, and Abington, together with the whole of the parish of Kingsthorpe. This increased the area of the town from 1,342 to 3,469 acres. Thus figures after this date are not strictly comparable with those before it. The change meant an increase from 23% to 29% in the proportion of the total population of the county living in Northampton.

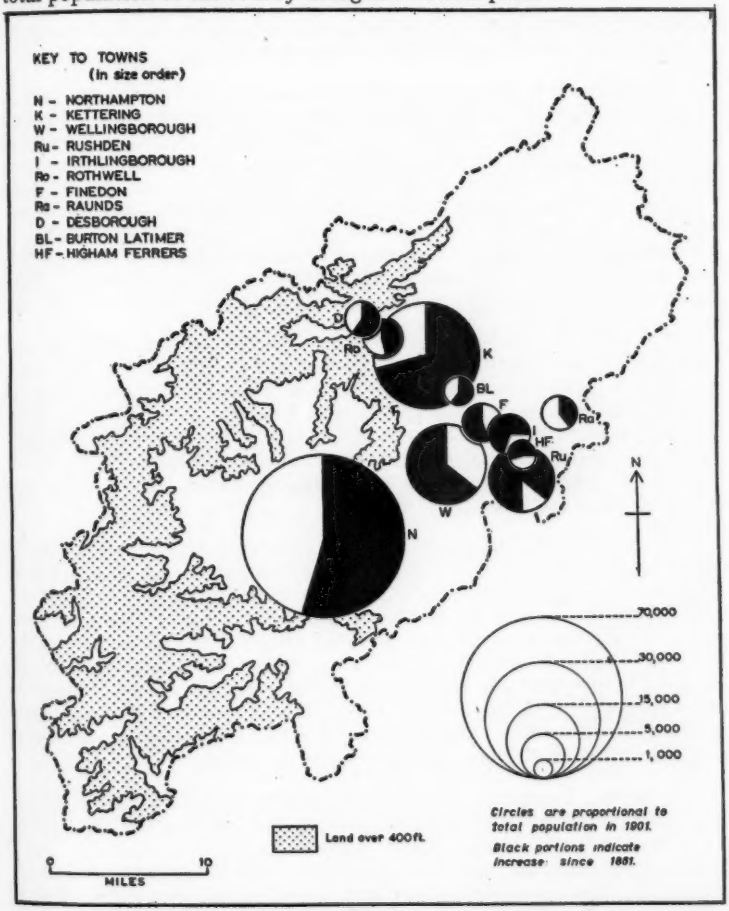

Fig. 5
Northampton and Ise Valley: total population 1901 and population growth 1861 to 1901.

The dominant factor of the 1861-1901 period was the Midland Railway opened in 1857, for while the agricultural areas of the county began to lose population at a great rate, the fact that the line ran through the Ise valley led to its period of greatest growth. During the years 1861-71 a general influx into the Ise valley was experienced. This was particularly marked in the case of Wellingborough where 2,000, that is 31% of the 1861 population, had entered since 1851. Kettering also began to gain population by migration, but at a lower rate. As in the previous period it would seem that the effects of iron mining combined with the shoe industry were the reason for the southern centres developing at a more rapid rate.

The decade 1871-81 saw the greatest numbers of immigrants into Wellingborough (2,500), an equal number entering Kettering, and a net in-movement of over 1,000 into Rushden. Large scale gains were also recorded by Irthlingborough in the south, and Desborough in the north both probably due to extensions in ironstone mining.

A decline in ironstone mining and smelting resulted in the sudden swing from high net in-movement to net out-movement from Wellingborough in the years 1881-91, a notable example of the influence of employment opportunities on the migration of population. In contrast Kettering and Rushden which were concentrating on the booming clothing and shoe trades, received over 9,000 migrants between them, over 50% of Rushden's population having entered between 1881-91 immediately following the opening of a Midland Railway branch line. Two other smaller industrial villages, Finedon and Wollaston (3 miles south of Wellingborough) also received immigrants during the decade.

The greatest movement into the Ise valley, during any one decade, came during 1891-1901. Again Kettering and Rushden were dominant, but were joined by a host of smaller centres : Raunds (3 miles north-east of Higham Ferrers), Irthlingborough, Irchester (2 miles south of Wellingborough), Higham Ferrers, Rothwell, Burton Latimer and Bozeat (5 miles south of Wellingborough). The fact that the country as a whole was in the depths of a depression probably increased the attractive power of these settlements.

After 1901 Northampton entered its third phase of population development, one of stagnation with net out-movement from 1901 to 1931 (Fig. 6). The total population grew by 9,000 during those years, while in the 40 years up to 1901 it had grown by 54,000. The period was also one of general out-movement from the county. It is noticeable, however, that each decade records in-movement into parishes surrounding the County Borough, especially Duston and Weston Favell (immediately to the east of the town). Thus while the County Borough itself declined in attractive power, the Northampton district was still maintaining its importance in the county as a whole.

When the boom-like nature of the growth of the Ise valley centres is taken into account, it is not surprising that, with a few exceptions, all centres were actually losing population by migration by 1911, although general trade conditions had improved. This loss is particularly marked in the case of Kettering which lost over 2,000 persons. Exceptions to this decline are Desborough, which attracted population to its developing iron extracting industry, and Burton Latimer which, being

a late starter in the period of influx, continued to attract migrants up to 1911.

From 1911 to 1921 the belt experienced an overall loss of population. Many centres, including Kettering, actually declined in total numbers and all lost population by migration. This would seem to be a period of reaction to the earlier growth and when trade once again began to slump after the boom conditions of the war had ended, the Ise valley reacted to the down-swing.

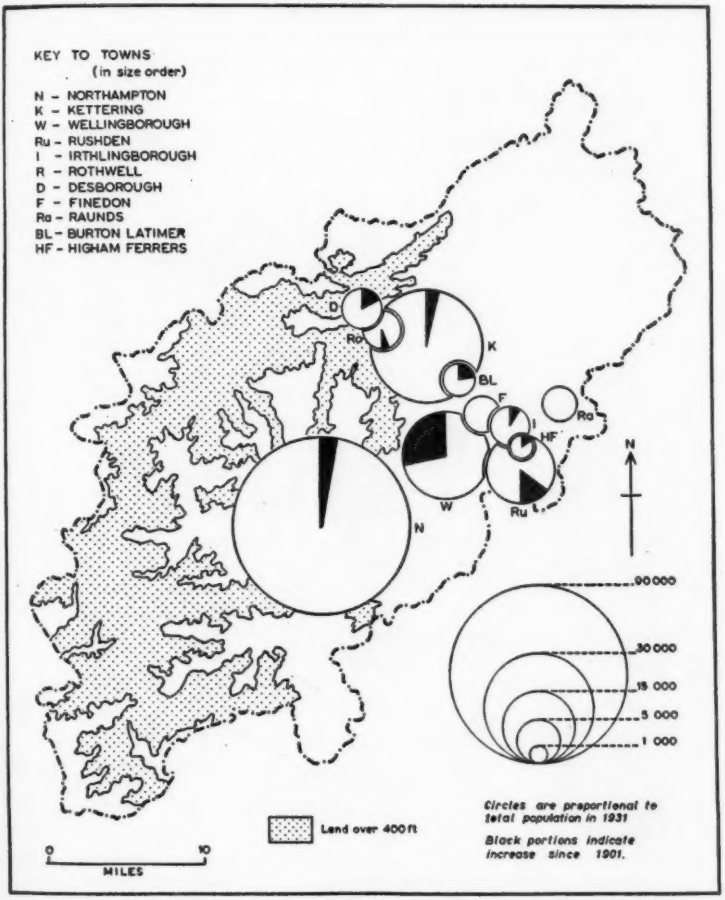

Fig. 6

Northampton and Ise Valley: total population 1931 and population growth 1901 to 1931.

The decade 1921-31 saw a slight revival on the part of the three chief towns and each gained slightly by migration. Barton Seagrave, a parish to the east of Kettering, had increased rapidly due to residential development connected with the town. This area was incorporated into

the borough of Kettering in 1935. The rest of the centres of the belt stagnated in population numbers, and suffered net losses due to migration.

The final phase of the population growth, 1931-51, spans the 20 year gap in census enumeration covering the war period. The gap can only be filled by using the less accurate figures from estimates for 1938 and the National Register of 1939, showing conditions immediately before and after the outbreak of war, and the estimates of 1947, showing conditions following the war.

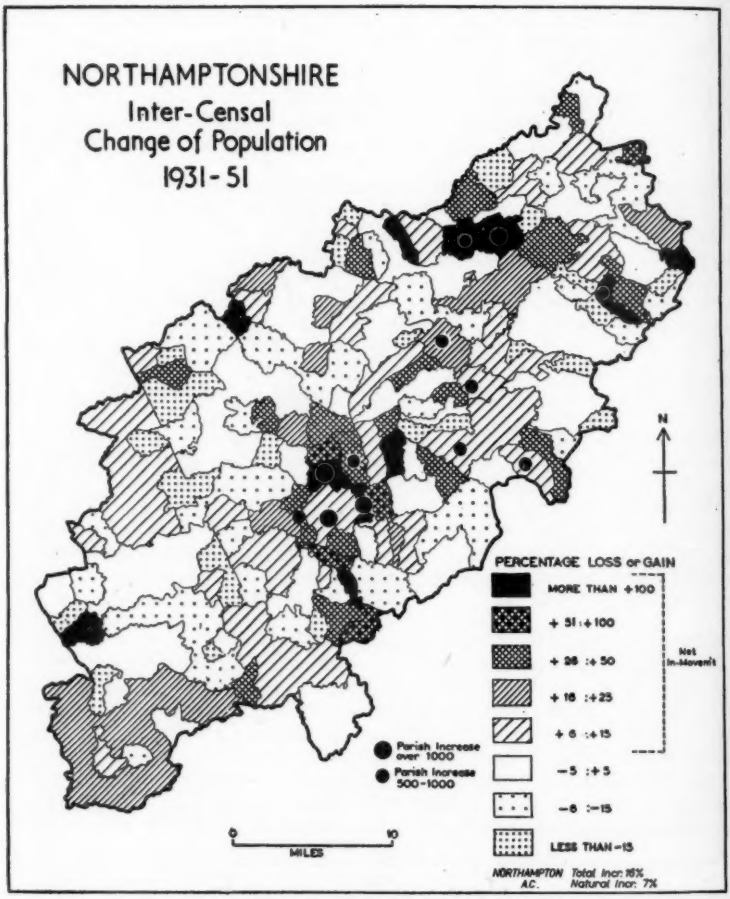

Fig. 7

With regard to Northampton the position of relative decline would appear to have continued until 1938 when the total population was 96,540 showing a slight fall in total numbers from 1931-38. In 1935 the County Borough further increased in area with the addition of parts of

the parishes of Boughton (north), Dallington, Duston, Hardingstone, Moulton Park (north-east), and Weston Favell, together with the whole of Far Cotton parish to the south. This practically doubled the area.

With the outbreak of war in 1939 nearly 13,000 evacuees were settled in the town, increasing its population to 109,392. Although wartime influences had ceased to operate by 1947 the town was still above 100,000. The population of the borough rose by 1,342 between 1947 and 1951, but natural increase was considerably higher than this figure, and net migration from the town may be assumed. Thus while net immigration is recorded during the entire inter-censal period, 1931-51, it would seem that a peak has been reached, and that movement to more open areas outside the town will continue.(1) This trend is clearly illustrated by Fig. 7 which shows large increases in the population of the parishes surrounding the County Borough. The greater part of this growth has been in the residential parishes of Boughton and Weston Favell but some has taken place in the parishes of Pitsford and Brixworth in the north and Wootton, Roade and Hartwell in the south. Thus it is the urban region of Northampton rather than the County Borough which must be studied in order to assess the importance of the town in relation to the rest of the county. In 1951 Northampton C.B. together with all contiguous parishes took up 32·6% of the total population of Northamptonshire.

The Ise valley from 1931-51 can be divided into the same pre-war, wartime and post-war periods. Up to 1938 each of the larger towns showed slight increases in population, and had begun to attract some migrants. In 1939 an influx of evacuees had swelled the numbers, although to a proportionately less extent than in much of the county. With the exception of Wellingborough these numbers had declined by 1947, and the 1947-51 period was marked by slight increases. The overall position was one of slow growth and on balance slight in-movement ; especially to Kettering and Rushden. Higham Ferrers also shared in this growth, but the remaining settlements were almost constant in population except for the smaller settlements of Bozeat and Wollaston which were actually declining. The figures of the 1957 estimates confirm that still little change is taking place. It may be that greater mechanisation in local industries is reducing the need for expansion of the total occupied population and that although the towns are maintaining their numbers, no rapid increase is to be expected.

Thus in 1951 Northamptonshire reached a new position in its population development. The steep rural decline, based on movement to urban industry from agriculture had been arrested, and the agricultural population was static at approximately 13,000 or 8% of the total. Rural areas were, however, increasing in population as a result of the development of transport and the wish on the part of many to live away from urban places of work. The previous centres of in-movement in the Nene and Ise valleys were increasing only very slowly in population, with their future development likely to be based on suburban growth in the surrounding parishes.

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(1) 1951 census : 104,432 ; 1955 estimates : 102, 800 ; 1957 estimates 101,000.

THE UNDERGROUND GASIFICATION OF COAL IN ENGLAND

K. C. EDWARDS

In January the National Coal Board announced that the experiments in the underground gasification of coal, which had been proceeding in this country for the past ten years, would cease. Little more than a week afterwards news was received of the arrival at Canvey Island in the Thames of the tanker *Methane Pioneer* bringing 2,000 tons of liquified gas from America, the first cargo of its kind to reach Britain. Both these events, though not in themselves connected, for the two kinds of gas serve quite different purposes, do however reflect the problem of satisfying the country's fuel and power requirements at an economic cost during the indefinite period before the use of atomic energy becomes general.

The work on gasification began immediately after the war at a time of acute coal shortage. It was hoped that this process might provide a means of utilising part of our coal resources more fully and more expeditiously than by relying wholly on normal methods of production. Since then the situation has radically changed and today supplies are abundant. Even the liquefied gas delivered at Canvey Island in order to supply the Romford gas works, was a trial load serving as an experiment in comparative costs and was not imported because of a shortage of gas-making coal. It is also on economic grounds that the decision to discontinue underground gasification has been made, for the vastly improved position with regard to normal coal output and the fact that the cost of gasification is barely competitive with other forms of power production do not justify further developments at present. Nevertheless, from the technical standpoint the operations have met with considerable success. For some years past gas has been produced by different methods and more recently, on an experimental scale, it has been put to practical use.

GASIFICATION AND ITS USES

Of course the idea of gasifying coal underground is not new; it was not new to the Russians when the process was effectively applied in the Soviet Union in the 'thirties, for Sir William Siemens suggested the possibility as early as 1868, while twenty years later more definite consideration was given to it by the Russian chemist, Mendeléev, who actually predicted the eventual elimination of underground coalmining by this means.(1) In England a patent was issued in 1909 relating to a method of burning coal at the foot of a shaft from which gas could be collected at the surface. This was followed by the planning of small-scale trials on the Durham coalfield by Sir William Ramsay in 1913 though progress was interrupted by the outbreak of the first world war and owing to Ramsay's death in 1916 the tests were not resumed. Experiments began in the Soviet Union however with the introduction of the second Five Year Plan in 1933. From work undertaken at Gorlovka in the Don Basin some success was achieved although trials made in the

(1) C. R. Lloyd Jones, "Underground gasification", *Trans. Inst. Mining Engineers*, vol. 109, 1950. The author of this paper also gives a considerable bibliography.

Kuznetsk Basin proved less satisfactory.[1] It appears nevertheless that in the 'thirties some limited use was made of gasification by the Russians for the production of electricity. Yet no large developments seem to have been made in more recent years. In the absence of authoritative information, it is thought that the amount of coal now gasified, after the restoration of war-damaged plant, is unlikely to exceed 100,000 tons per annum.

After the second world war experiments were made in several other countries, notably in Belgium near Liege, in Italy at Valdarno and on the Silesian coalfield in Poland, while a French concern (Charbonnages de France) conducted trials at Djerada in Morocco. For varying reasons however these attempts have all been suspended. In the U.S.A. operations at Gorgas (Alabama) have resulted in the production of small quantities of gas by techniques broadly similar to those developed in the U.S.S.R. and in England.[2] At Hume (Missouri) a different process, involving electrical carbonisation, has been investigated.

Essentially the process of gasification consists of directing a current of air through a coal seam which is burning under controlled conditions. The result is the formation of a combustible gas which is collected at the surface. Such gas, according to its quality, can be used for three main purposes : (*a*) for transmission by pipeline as a source of power (in which case oxygen or oxygen-enriched air is required) ; (*b*) for the synthesis of liquid fuels ; and (*c*) to operate gas-engines for the generation of electricity. The gas obtained as a result of the trials made in this country, being of low calorific value, is suitable for electricity production and if output on a commercial basis were possible it would be used primarily for that purpose.

The Sites for Experimental Work

The operations concerned with gasification have aroused great interest in the East Midlands because the first and also the leading centre chosen for experiment was situated near Chesterfield on the North Derbyshire coalfield (Fig. 1). Later on another centre was chosen in the West Midlands on one of the small detached coalfields across the Severn in Worcestershire which afforded somewhat different conditions. From the beginning the aim was to treat the thinner seams not economically workable by ordinary methods, thus helping to counteract the dwindling number of miners. It was also decided, in order to avoid excessive costs, to deal only with horizontal or slightly inclined seams lying relatively near the surface.[3]

Work began on the site at Newman Spinney about 7 miles N.E. of Chesterfield in 1949 and the first gas was obtained in the summer of 1950.[4] Drilling on the Worcestershire site at Rockmoor Farm, Bayton,

(1) F. S. Atkinson, "Underground gasification of coal in the U.S.S.R.", *Colliery Engineering*, vol. 14, April 1937.

(2) J. L. Elder and E. T. Wilkins, "The underground gasification of coal in the U.S.A.", *Journ. Inst. of Fuel*, vol. 24, May 1951.

(3) Ministry of Fuel and Power, *British trials in underground gasification*, 1949-55, H.M.S.O., 1956. This report, though technical in character, gives a full illustrated account of the experiments undertaken during the period referred to in the title. See also *Times Review of Industry*, Aug. 1953.

(4) C. A. Masterman, "Underground gasification trials near Chesterfield during 1950", *Journ. Inst. of Fuel*, vol. 24, Jan. and Mar. 1951.

See also C. A. Masterman, "Underground gasification in Britain", *Iron and Coal Trades Review*, vol. 165, Aug. 1952.

10 miles W.S.W. of Kidderminster, began in 1951. Though broadly comparable as regards general conditions, the two sites presented significant differences in detail. At Newman Spinney three seams were available for treatment, the Fox Earth, Sough and Furnace, each 3 ft. thick, separated by bands of shale and clay, and lying at 60 ft., 100 ft. and 130 ft. respectively below the surface. These seams showed a uniform dip of 1 in 7 and were unfaulted. At Bayton there were four seams, the Rockmoor Minor, Broseley, Bank Farm and Hard Mine, of varying thickness. The Rockmoor Minor seam was only 1—1½ ft. thick, the Broseley 2½ ft., the Bank Farm 6 ft., while the Hard Mine varied from 2—2½ ft. While the general dip was about 1 in 5, these seams were considerably faulted, causing depth from the surface to vary from one part of the site to another. The lowest of them, the Hard Mine, ranged from 180 ft. to 300 ft. in depth. Although the throw of the faults was in most cases slight and of no consequence to normal mining, such displacements created a major difficulty to gasification.

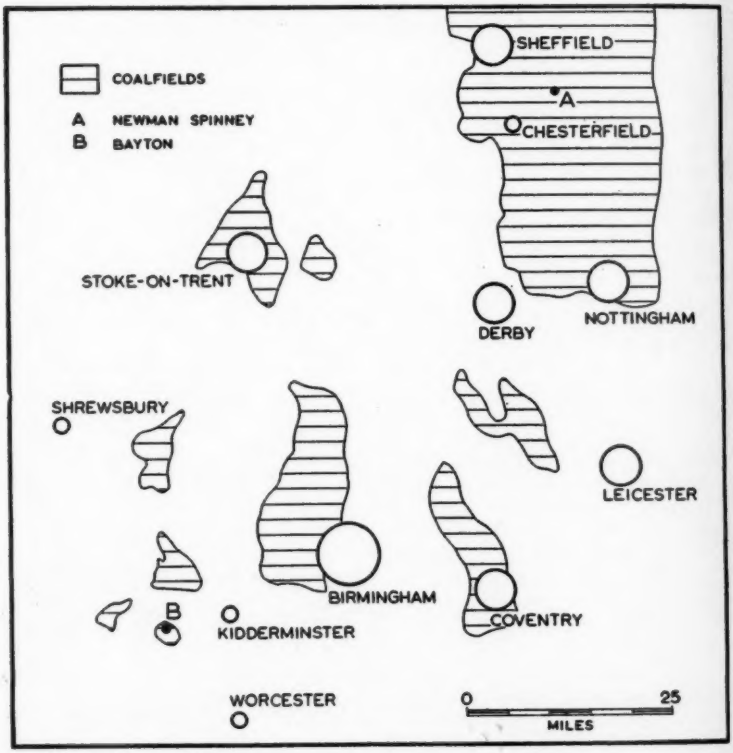

Fig. 1
Location of underground gasification sites.

The seams at Newman Spinney were of medium coking type while those in Worcestershire were non-coking, yet the two groups showed little difference in their gasifying properties. In both cases the overburden, consisting of clays and shales, was sufficiently compact to

prevent gas dissipation. Newman Spinney however was especially favourable for experimental tests since the site was an opencast-working in which the uppermost seam, the Fox Earth, was exposed to view. By 1954, when operations were well advanced at both places, it was estimated that the 16 acre site at Newman Spinney contained an aggregate of 221,000 tons of coal and the 11 acre site at Bayton 215,000 tons.

Gasification Techniques

The process of gasification is a highly technical matter and in the course of ten years' intensive trials numerous techniques and procedures have been adopted and discarded on both sites until success was attained. Without going into detail however some of the main problems affecting the progress of the experiments can be briefly stated.

In the first place the actual ignition of coal underground is not a particularly difficult problem and can be done in several ways by using butane or propane (electrically ignited), hydrogen, or more conveniently by an electric resistance element with wires connecting it to the surface. Of far greater complexity is the question of gaining access to the coal. Here the earlier experiments were greatly hampered by a condition imposed by the Ministry of Fuel and Power that all preparatory work had to be done at the surface. In these circumstances the principle adopted was that of drilling boreholes down to a seam and making a passage through the coal to connect the base of one bore to the base of another. Thus after igniting the coal, gasification resulted from air passing down one borehole, the gas itself rising up the other. Here the difficulty lay in making the channel through the coal, to which an ingenious solution was found by using high pressure air in order to burn the required passage. Neither this nor alternative methods however proved really satisfactory.

Eventually in 1953, since it was necessary to establish a successful process as soon as possible, the condition regarding surface preparatory work was relaxed and a new and more hopeful phase of investigation began. The acceptance of underground preparations enabled the gasifying channels to be drilled in the plane of the coal seam from galleries at coal level reached from the surface by small shafts. This procedure was greatly helped by the introduction of directional drilling, a technique first developed in connection with long-wall mining.[1] This is a particularly accurate form of drilling by which the drill can penetrate a thin seam for long distances. At Newman Spinney for example a bore was kept within a 3 ft. seam for nearly 200 yards. Directional drilling therefore became the basis for all subsequent gasification trials.

With the use of directional drilling two contrasted methods of gas production were systematically investigated. These are known as the gallery-to-gallery and blind borehole methods respectively.[2] In the first case boreholes are drilled in the coal from one gallery to another about 200 yards distant (Fig. 2). The galleries, as mentioned above, are at the level of the seam, having been driven from small shafts reaching

(1) C. A. Masterman, "Underground gasification trials 1951-52, in Britain", *Journ. Inst. of Fuel*, vol. 25, May 1953, p. 434.

(2) Ministry of Fuel and Power, *op. cit.*

from the surface. The boreholes are placed at suitable intervals so as to leave as little coal as possible ungasified. Others drilled in the opposite direction would connect parallel galleries, thus extending the area of operations. Air is passed down a shaft to one gallery and the gas, accumulating in the next gallery, reaches the surface by another shaft. In the case of the blind borehole, the seam is drilled so that the further end of the borehole remains closed. The air is supplied by means of a pipe within the borehole. Since the reaction occurs at the closed end of the latter, the gas passes in the return direction between the air pipe and the borehole wall. In so doing some of its heat is imparted to the incoming air and this causes the reaction to promote an improvement in calorific value. Blind boreholes can be used in parallel groups or radially around the base of a single shaft.

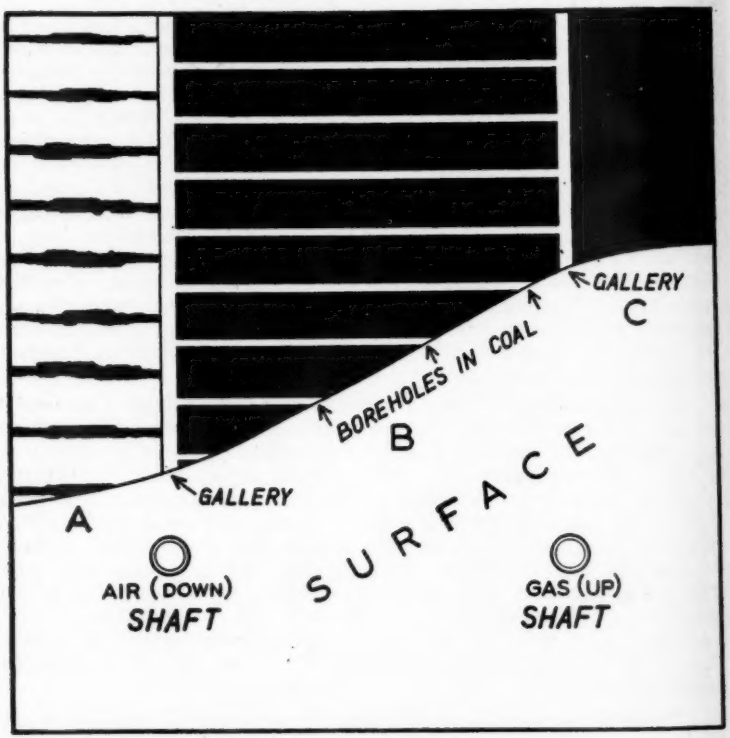

Fig. 2

Gallery-to-gallery method of underground gasification. A—part of seam already gasified. B—part in process of gasification. C—part to be gasified. (Based on Ministry of Fuel and Power, *British Trials in Underground Gasification*, 1949-55).

Several tests at Newman Spinney proved that gasification by means of blind boreholes offered advantages, both technical and economic, over the gallery-to-gallery method (Fig. 3). Particularly in view of the superior calorific value of the gas and the smaller number of galleries

and shafts required for blind boreholes, no further development of the gallery-to-gallery process took place. This does not necessarily mean that the method has been abandoned. On the other hand while the blind borehole provides the most satisfactory application of directional drilling, many technical points require consideration before the system could be accepted for large-scale use on a commercial basis. Perhaps the most important difficulty of all lies in the fact that so far there is insufficient control over the underground burning which often leads to too high a proportion of the coal being left ungasified.

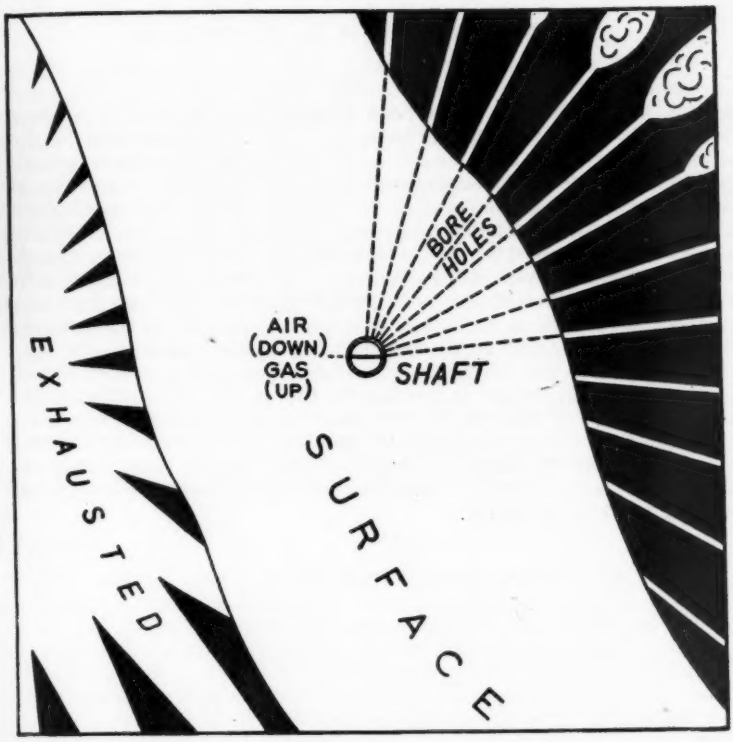

Fig. 3

Blind borehole (radial) method of underground gasification. (Based on Ministry of Fuel and Power, *British Trials in Underground Gasification*, 1949-55).

In concluding these remarks on the technical problems involved in gasification, it is interesting to note that both in Derbyshire and Worcestershire the trials caused little surface subsidence. Even where seams close to the surface were treated, the effect was comparatively slight. This is largely because in the reaction only the combustible constituents of the coal are removed; moreover the roof and floor of the seam tend to swell under the heat of the burning coal, thus reducing the intervening space. It is probable therefore that in operations on a

more extensive scale subsidence would be less than that resulting from conventional mining. About half the thickness of the seam is regarded as the likely amount.

If conditions had warranted developments on a commercial scale, a large reserve of coal exists in the country for the purpose. Even if operations were confined to the treatment of gently dipping seams of a minimum thickness of 2 ft. 6 ins. lying no deeper than 600 ft. in areas reasonably free from surface buildings, the amount available has been estimated at 300 million tons.

The Value of the Experiments

Much has been gained from the intensive trials undertaken during the past decade. Innumerable problems have been encountered and solved, new techniques have been devised and successfully applied, while valuable experience has been acquired by experts and highly-skilled operatives. Not the least important feature of the experimental phase has been the co-operation of those concerned with similar operations in Russia and America. In fact one of the two chief gasification processes eventually adopted at Newman Spinney was evolved from a method used in the Soviet Union largely as the result of exchange visits by experts from both countries. The technical achievements represent an important asset in themselves and it is hoped that they may prove valuable in the export field, for it is likely that the processes developed in England could be profitably applied abroad. In some countries gasification would have a greater chance of economic success than is the case at present in treating the thin seams of British coalfields. Its application to both thick and steeply dipping seams, which are a feature of some continental coalfields, might well prove more satisfactory than extraction by ordinary mining. Before such a stage is reached however the major difficulty of inadequate control over the underground burning must be overcome.

THE LOCAL ACCESSIBILITY OF NOTTINGHAM

PETER A. BROWN

In recent years, geographers have made increasing use of bus service data as a means of defining and analysing urban spheres of influence. Not least among the difficulties involved in work of this kind is the cartographic problem of mapping bus service data in a satisfactory manner. Frequency of buses can be effectively represented by means of flow diagrams and mapping this aspect of services raises little difficulty, but on the other hand no adequate method seems yet to have been devised of portraying the equally important patterns shown by speed of service and fares. The main purpose of this article is to present, in the form of a case study dealing with Nottingham, some techniques of showing these aspects of bus services on maps in the hope that they may be of use to studies of local accessibility for other areas. An attempt is made also to interpret some of the more outstanding features revealed by these maps which, it is felt, may similarly be of relevance to geographical analysis of the bus services of other parts of the country.

PATTERNS OF ACCESSIBILITY

The pattern of bus routes terminating in central Nottingham and the major settlements they serve is displayed in Fig. 1. This map is intended to provide a key to those discussed later in this article though few direct references are made to it in the text.(1)

Frequency.

Frequency of buses to central Nottingham is shown in Fig. 2. This map indicates the total number of buses travelling to within a quarter of a mile of the city centre during the weekday on which services are at a maximum i.e. for most routes on Saturdays but in a few cases on mid-week market-days. For the sake of clarity no attempt has been made to map services within the city boundary. Since timetables vary considerably with time of day, it seems preferable to indicate frequency by showing the total daily number of buses rather than the average interval between successive services.

Two striking features are apparent from Fig. 2 :—

(1) There are marked concentrations of frequent services in the densely populated areas that occur on the Nottinghamshire and Derbyshire Coalfield to the north and north-west of Nottingham, in the Middle Trent and lower Derwent valleys to the west between Nottingham and Derby, and in the suburban districts of Arnold, Carlton and West Bridgford, which border the city on the east and south.

(1) This article is concerned only with stage-carriage bus services; no consideration is given to express services or to those with limited stops. All maps are based on data for the winter of 1955-1956.

(2) Much less frequent services run through the more thinly populated districts to the north-east, east and south of Nottingham though the majority of these terminate in moderately sized, if relatively isolated urban centres (e.g. Doncaster, Retford, Newark, Grantham, Melton Mowbray, Loughborough and Coalville) and one provides a link with Leicester. The least frequent of these services tend also to be the least direct, particularly those running from the thinly populated agricultural districts of :—

(*a*) the Vale of Belvoir to the south-east of Nottingham ;

(*b*) the lower Soar valley to the south-west ;

(*c*) the hilly Keuper country lying to the north-east of Nottingham between the city and the small market town of Southwell.

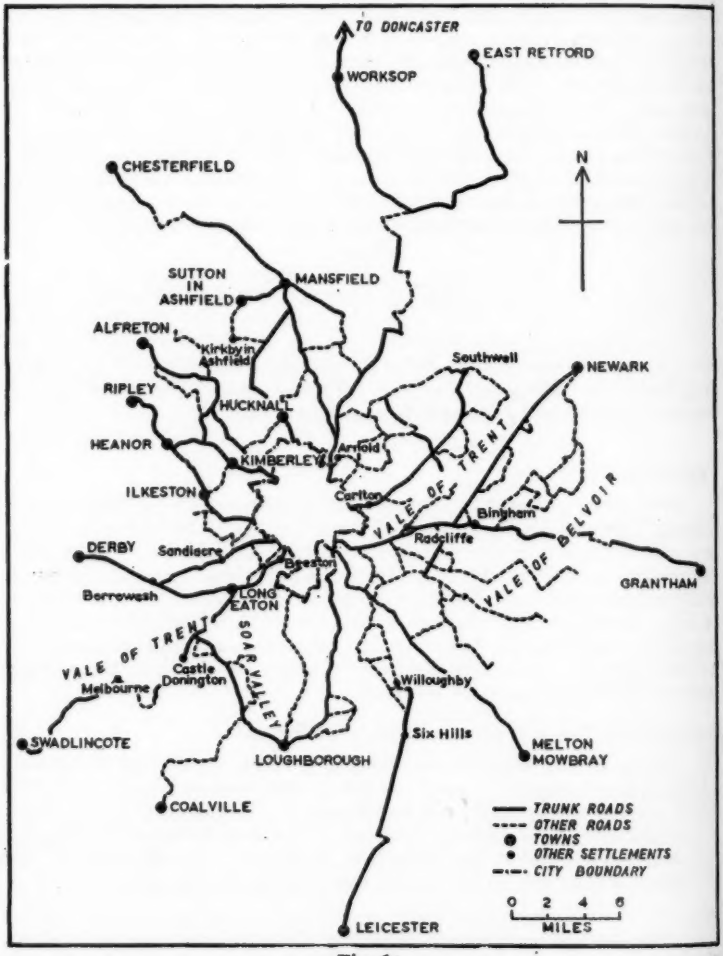

Fig. 1
Nottingham area : key map.

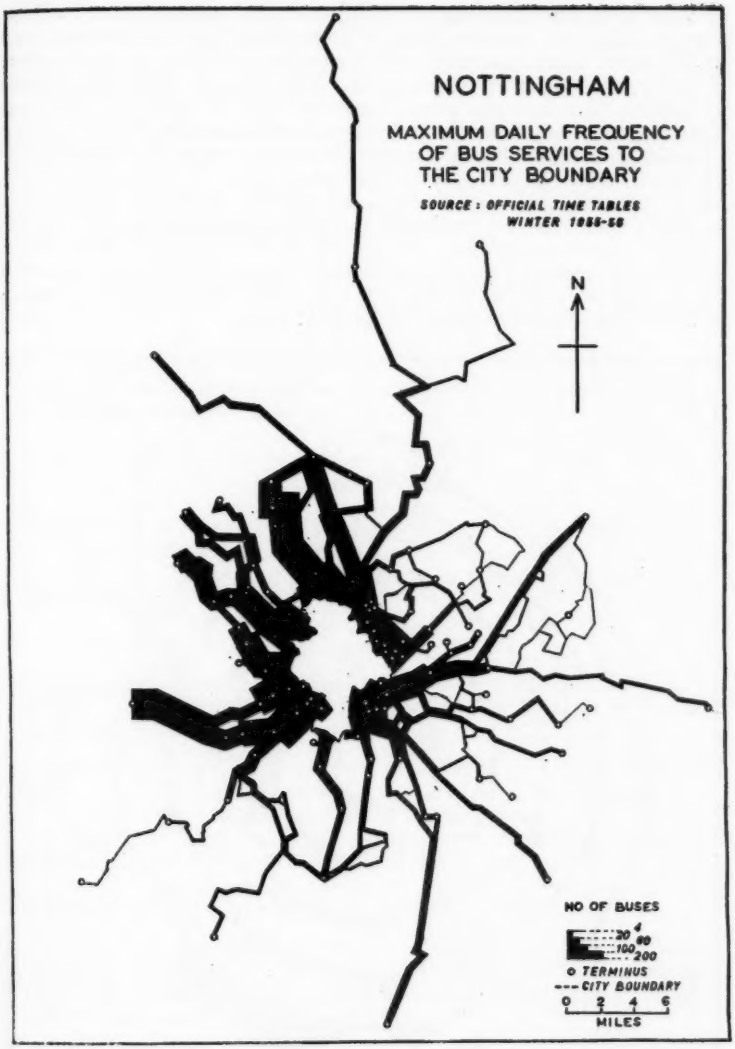

Fig. 2

Speed.

An attempt is made to map the speed of bus services centring upon Nottingham in Fig. 3. In order to construct this map, journey times to central Nottingham were first plotted at 10 minute intervals along all bus routes and the points so marked were connected by interpolated lines to form complete isopleths. Routes are in fact omitted from the final map to avoid confusion, but solid lines shown in the isopleths in Fig. 3 indicate where they actually intersect bus routes, while the

interpolated connecting sections are dotted. To emphasise the resulting pattern, distance is indicated by concentric circles drawn at intervals of 2·5 miles from the centre of Nottingham. These circles showing distance were selected to coincide approximately with the various isopleths. Thus, on average it takes 10 minutes to travel $2\frac{1}{2}$ miles to or from central Nottingham, 20 minutes to travel 5 miles, 30 minutes for $7\frac{1}{2}$ miles and so on. Where an isopleth extends beyond the related circle the intervening space is shaded and where an isopleth lies conversely within the circle the area between is stippled. In effect a shaded area on Fig. 3 indicates comparatively rapid speed of travel while a stippled area indicates the opposite. The map must be interpreted with caution since the isopleths are fully substantiated only in parts but the completed pattern has the advantage of giving a bold *relative* impression of speeds of travel along different routes in different areas.

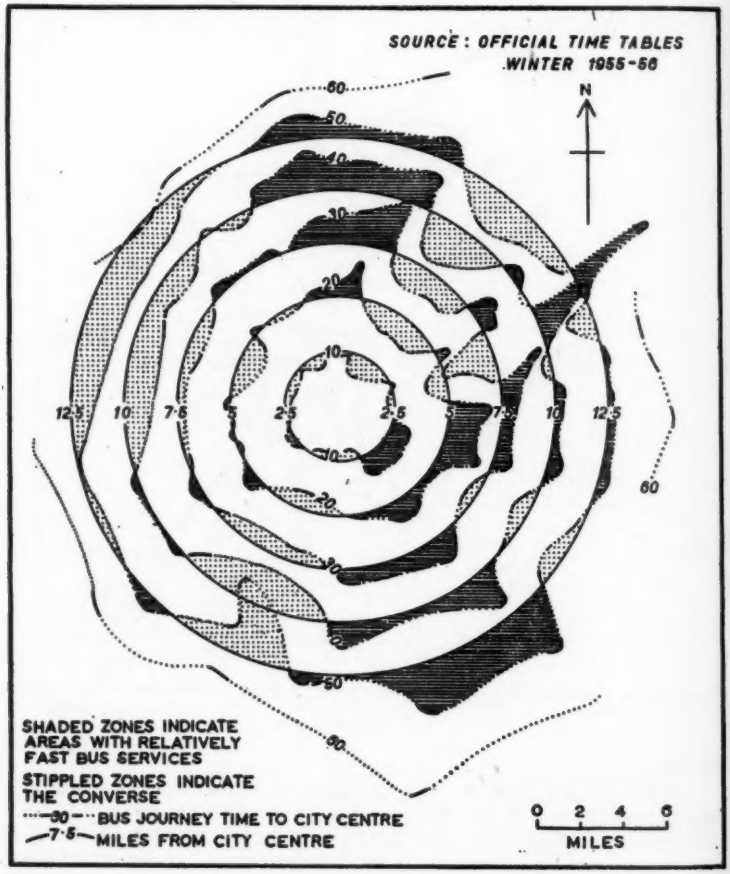

Fig. 3

Nottingham : speed of bus services.

The most significant point revealed by Fig. 3 is that speed shows a pattern of accessibility which is to a large extent the reverse of that based on frequency. The very frequent services running from the densely populated areas noted in Fig. 2 are in most cases relatively slow, while in contrast many of the less frequent services from the more thinly populated districts are comparatively fast. The infrequent circuitous services running through the Vale of Belvior, the lower Soar Valley and the Keuper Country north-east of Nottingham are slow in addition to being infrequent, however, so that here there is agreement between the patterns of accessibility displayed by frequency and speed.

Clearly, speed of service is determined largely by degree of traffic congestion, frequency of stops and directness of route so that the features shown in Fig 3 require little explanation, but their significance is revealed by an examination of Fig. 4, which is an attempt to show the pattern of accessibility resulting when both speed and frequency are combined. This map was constructed by adding the journey times shown in Fig. 3 to half the average interval between successive buses along each route. In drawing the isopleths, time spent in walking to the nearest bus route was also taken into account and for this purpose, walking speeds were calculated at an arbitrary rate of 1 mile in 20 minutes regardless of detours. The completed isochrone pattern (1) gives an approximate but reasonably realistic indication of the total time required to reach Nottingham by bus from all areas within an hour's journey from the city centre. Circles showing distances are added to give scale to the map.

Three important features are apparent on Fig. 4 :—

(1) Despite comparatively slow speeds of travel the major urban areas located in the Coalfield(2) and those between Nottingham and Derby are the areas most accessible to the city.

(2) Comparatively rapid speed of travel on many of the more direct but less frequent services compensates to a large extent for their low frequency. Fig. 4 clearly shows that total journey times on the relatively infrequent but fast services from Doncaster, Newark, Melton Mowbray, Leicester and Loughborough compare very favourably with those on the much more frequent but slower services from Derby and the coalfield.

(3) As a result of services which are both slow and infrequent the rural areas in the Keuper country to the north-east of Nottingham, in the Vale of Belvoir (to the south-east), and in the lower Soar valley (to the south-west) are very inaccessible.

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(1) A similar map to Fig. 4 is described in : R. Kok, "Isochrone Maps for the Hague", *Tijdschrift voor Economische en Sociale Geografie*, vol. 42, 1951, p. 261.

(2) Three localities in the coalfield to the north-west of Nottingham are relatively inaccessible. The first occurs in the neighbourhood of Newstead Abbey to the south of Mansfield, the second around Annesley Park to the north-west of Hucknall, and the third near the villages of Strelley and Cossall to the east of Ilkeston. All three are thinly populated parkland areas. In addition, there is a markedly inaccessible area centred on the village of Dale Abbey to the west of Nottingham. This too is relatively sparsely populated and lies between the southern margin of the exposed coalfield and the belt of urbanised settlements linking Derby with Nottingham. It falls within the sphere of influence of the former rather than the latter city.

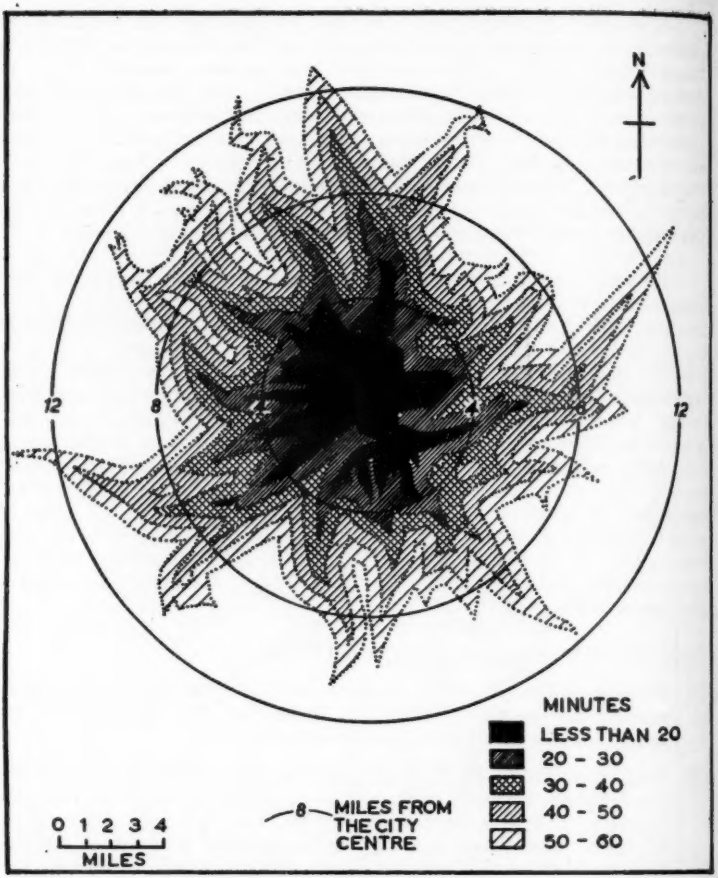

Fig. 4
Nottingham : accessibility by bus.

Fares.

Isopleths based on fares, illustrated in Fig. 5(1) display quite a different pattern showing wide variations between services which have been noted in other respects to be similar. Fares are, for instance, relatively low on services from the urban settlements of the Nottinghamshire and Derbyshire Coalfield but on those from the comparable settlements located between Nottingham and Derby they are much higher. By far the lowest fares shown in Fig. 5 occur on the services from Grantham and Swadlincote which run for considerable distances through rural areas. They are relatively low too on the services from Doncaster and Melton Mowbray but on those from Newark, Loughborough and Leicester, which are similar in terms of speed, frequency and type of area served, fares are quite high. With regard to the rural area to the

(1) This map was constructed by the method employed in Fig. 3, described above.

north-east of Nottingham, the lower Soar valley, and much of the Vale of Belvoir, the pattern shown by fares correlates with the patterns based on frequency and speed since these primarily agricultural districts are among the least accessible shown in Fig. 5. But with this exception the isopleths of fares are largely inconsistent with those representing the other aspects of services. It seems clear that fares are governed largely by different factors from those determining frequency and speed, and because of this marked inconsistency no attempt has been made here to formulate an index of accessibility taking all three aspects of bus services into account.

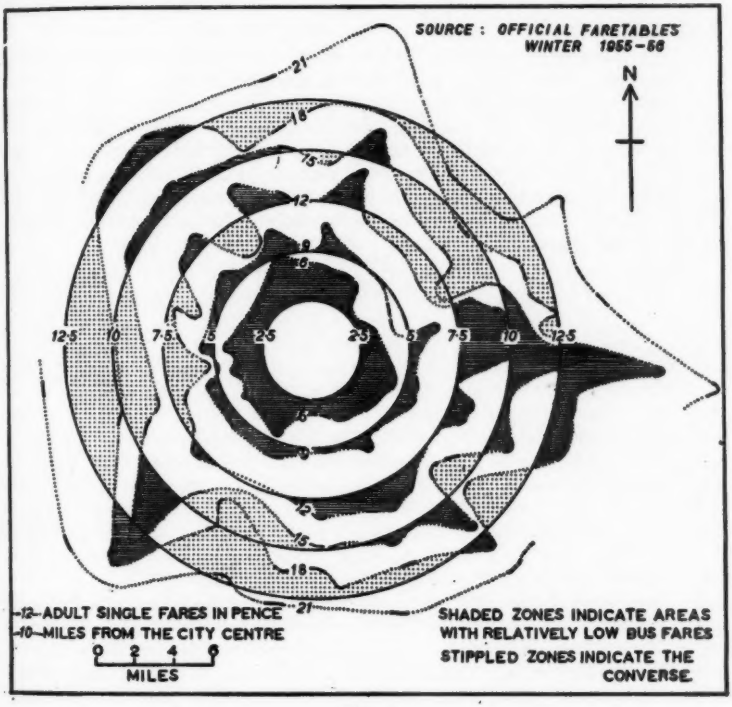

Fig. 5
Nottingham : bus fares to the city centre.

Analysis of the Patterns

Limitations of space do not permit a complete and detailed analysis of the patterns so far described, but several points deserve discussion.

For nearly thirty years, the operation of motorbus services in Great Britain has been subjected to the approval and supervision of a regional system of Licensing Authorities initially established in 1930 by the first Road Traffic Act.(1) The major aims behind this legislation were twofold : first, to ensure the provision of services consistent in frequency,

(1) *Road Traffic Act*, 1930, (20 and 21, Geo. 5. Ch. 43).

speed and fares with the volume and character of demand, and second, to prevent the occurrence of wasteful competition, not only between different bus companies, but also between road and rail passenger transport. In order to achieve these objectives the Licensing Authorities were empowered to modify or even prohibit services which were not in accordance with the aims specified above. Quite clearly, any geographical examination of local transport facilities must take these factors into account. The remaining part of this article is therefore concerned with an analysis of the patterns previously described in relation to the aims of the 1930 Act.

The Problem of Demand.

The problem of ascertaining how far in fact the Licensing Authority has ensured a close correlation between the provision of bus services to Nottingham(1) and the demand for these services is extremely complex, and could perhaps be adequately solved only by use of detailed questionnaire analysis and through access to bus company loading data for the area concerned. For various reasons, neither of these lines of approach is feasible and a complete solution of the problem is therefore difficult to make. Certain tentative conclusions can be reached, however, by other means of investigation.

There is little doubt that the demand for bus services arises primarily from the need for transport to places of work and to centres of shopping and entertainment. Each of these various aspects of demand tends markedly to predominate at different times of day. Obviously, for example, between the hours of 7 and 9 a.m. most passengers are travelling to work, while in the period from 10 a.m. to 12 noon the majority are travelling on shopping journeys. Frequency of services to central Nottingham has been mapped for these and other significant periods and quite different patterns are revealed, each presumably reflecting the prevailing character of demand. Some indication of the journey-to-work movement to Nottingham and of the movement of shoppers to the city can be gained from surveys undertaken about ten years ago in the North Midland Region of the Board of Trade by the former Ministry of Town and Country Planning.(2) Comparison of maps based on these data(3) with maps showing frequency of bus services to the city centre during appropriate periods of the day, reveals a close and detailed correlation, suggesting that with regard to frequency at least the first objective of the 1930 Act has in large measure been achieved. A similar conclusion cannot be made concerning fares since except in the most thinly populated areas, these are largely at variance with the patterns displayed by other aspects of bus services, and show little affinity to the pattern of

(1) The areas linked by bus with Nottingham are controlled by the East Midlands Licensing Authority which is responsible for the greater parts of Nottinghamshire, Derbyshire and Lincolnshire; the whole of Leicestershire, Rutland and Oxfordshire; south-western Bedfordshire, northern Berkshire and much of Northamptonshire and Buckinghamshire.

(2) Now the Ministry of Housing and Local Government.

(3) Further details of the demand for transport to Nottingham for shopping purposes can be inferred from a study of the shopping facilities of the surrounding urban settlements as recorded by Smailes, and from an examination of the retail sales statistics of these settlements, see: A. E. Smailes, "The Urban Hierarchy in England and Wales", *Geography*, Vol. 29, June 1944; and P. A. Brown, "Centres of Retail Distribution in the East Midlands", *East Midland Geographer*, No. 6, December 1956.

population and, so far as can be ascertained, bear little direct or consistent relationship to demand. It seems likely that fare structures are complicated by subsidies for "it was part of the purpose of the licensing system that by introducing order into the (road passenger transport) industry and giving a substantial measure of protection to the regular operator it would facilitate the provision of unremunerative services ..... In so far as the cost of such services is not met by the users, the cost has to be met from some other source. Most frequently this is the remunerative service".(1)

The Problem of Competition.

Freedom of competition prior to 1930 proved conclusively that bus services, and indeed all forms of public transport involving regular services, can be satisfactorily provided only under economic conditions approaching monopoly. Operating costs in public passenger transport are to a large extent determined by the pattern of demand and the load factor obtained. Since the demand for transport fluctuates greatly from time to time during the day, on different days of the week and from place to place, resulting costs per passenger mile vary considerably. Typical daily variations in operating costs on bus services have been estimated to range from ½d. to 4d. per passenger mile in towns, where differences in volume between peak and off-peak demand are most pronounced, and from ½d. to 3d. on country services which are subjected to relatively smaller fluctuations of demand.(2) Obviously, the provision of adequate services at all times of day involves large standby capacity for use only at peak periods, while fixing fares to schedule necessitates the smoothing-out of variations in operating cost. Neither can be achieved without conditions of quasi-monopoly.

The 1930 Act consequently authorised the prevention of wasteful competition firstly between different bus service operators and secondly between bus services and the railways. In the first respect the Act appears to have been largely successful with regard to the services centring on Nottingham. Apart from municipal transport, which has special protection rights,(3) bus services to Nottingham are provided by four large companies and two much smaller ones. Competition is precluded by the fact that each company has acquired monopoly over a distinct group of routes. Few routes are served by two or more companies and in cases where this occurs the different operators have made working agreements under encouragement or pressure from the Licensing Authority.(4)

One exception is notable however. A two-hourly bus service runs from Swadlincote via Castle Donington to Nottingham (see Fig. 1) and between Nottingham and a point some four miles south-west of Castle Donington it follows the same route as an hourly semi-express service,

(1) Report of the Committee on the Licensing of Road Passenger Services, London, H.M.S.O., 1953, p. 39.

(2) See : Sir Reginald Wilson, "The Framework of Public Transport", *Journal of the Institute of Transport*, Vol. 25, 1953, pp. 145-185.

(3) For the effect of these rights of protection on the local accessibility of Nottingham see : P. A. Brown, "Some Problems of Bus Services in Nottingham", *University of Nottingham Survey*, Vol. 8, Dec. 1957, pp. 5-9.

(4) e.g. Services between Derby and Nottingham are provided by two separate companies and, in order to prevent competition, fares and journey times have been closely equated, though in fact one service follows a partially different and slightly longer route than the other. (see Fig. 1).

which runs from Birmingham and is provided by a different company. The Licensing Authority has prohibited the Birmingham service from carrying local passengers anywhere between Castle Donington and Nottingham, presumably because this section of the route is adequately served by stage carriage buses (see Fig. 2) while the function of the Birmingham service is to carry longer-distance, semi-express traffic. To the south-west of Castle Donington, where the services from Birmingham and Swadlincote continue to follow the same route for about four more miles, no restrictions are imposed however. The Birmingham service is here more frequent than that from Swadlincote and, being prevented from stopping to pick-up or set-down local passengers between Castle Donington and Nottingham, it also has a marked advantage over the latter in speed. On the other hand, as reference to Fig. 5 clearly shows, single fares on the service from Swadlincote are remarkably low over the unrestricted section of the route, in fact considerably undercutting those on the service from Birmingham, and there is little doubt that this is the result of competition between the two companies involved.

It now remains to examine the problem of competition between bus services and the railways. In the densely populated areas of the coalfield to the north-west of Nottingham this problem no longer seriously arises. It is generally acknowledged that in urban areas of this kind the bus service is the superior form of transport for local travel because of its greater flexibility and more numerous stopping places. The railway has advantages for local urban traffic only in large conurbations and metropolitan centres where congestion on the roads renders bus services inadequate in frequency and speed.

Hence, the railways would appear to have abandoned the attempt to cater to any significant extent for short distance travel between Nottingham and the coalfield. The frequency of local passenger trains here is greatly restricted by high densities of goods traffic and for the same reason, as Table I illustrates, trains from the coalfield have little or no advantage over buses in speed. Thus in recent years, presumably because of their inability to compete satisfactorily with buses, rail passenger services from the mining town of Sutton-in-Ashfield have been withdrawn while frequency on the service from Mansfield to Nottingham has been greatly reduced.(1)

TABLE 1

APPROXIMATE TRAIN AND BUS JOURNEY TIMES TO NOTTINGHAM FROM VARIOUS NEARBY URBAN CENTRES, IN MINUTES.

(Towns located on the coalfield are indicated thus : *).

Centre.	*Fast trains.*	*Slow trains.*	*Buses.*
*Worksop	—	90	60
*Mansfield	40	45	45
*Kirkby-in-Ashfield	—	34	45
*Hucknall	12	21	21
*Ilkeston	25	37	27
*Alfreton	—	58	70
Derby	30	45	57
Leicester	30	50	78
Loughborough	21	30	50
Melton Mowbray	25	34	57
Grantham	33	48	85
Newark	27	40	50

(1) At the same time it is necessary to note that rail connections between Derby and Nottingham have been improved by the introduction of diesel services, but even with this improvement it is doubtful if the railway can compete effectively for local urban traffic because inaccessibility of the stations in Derby and several intermediate settlements would seem to detract from the advantage these trains hold in speed.

On lines from the more isolated urban settlements (e.g : Newark, Grantham, Melton Mowbray and Loughborough) by contrast, passenger trains are not only much faster than buses (see Table 1) but are also comparable in frequency. Over journeys of this kind the likelihood of competition arising between road and rail transport is therefore much greater and several features of the bus service patterns infer that keen competition is in fact taking place. The following three examples seem worth recording :—

(1) Trains between Newark and Nottingham are less frequent than buses but complete the journey more quickly and run at hourly intervals. Bus services follow several slightly varying routes between the two centres (see Fig. 1) and the most direct, running also at hourly intervals, is the fastest of all services entering Nottingham (Fig. 3). Unlike any other bus service traversing comparatively thinly populated areas, the latter follows a very direct route which by-passes several large villages and runs through only one small settlement on the seventeen mile journey between Newark and West Bridgford on the outskirts of Nottingham. This must surely be a competitive attempt to reduce the advantage that the railway has in speed.

(2) A comparison of bus and train services linking Nottingham with Leicester provides clear evidence of further competition for through traffic(1) In terms of frequency, road and rail services between the two cities are similar but as Table 1 shows trains are superior in speed. In fares the advantage is reversed since the single bus fare of 2/5d. costs considerably less than the single journey by train (3/10d.). The railways undercut the return bus fare, however, by offering a cheap day return rate of 3/3d., and to compete with this concession a special day return of 3/- is made available on the bus. As a result of these competitive prices, the day return bus fare from Nottingham to Leicester costs only 1d. more than the return journey by bus from Nottingham to Six Hills, which lies no more than halfway between the two cities.

(3) Competition is also revealed by a study of road and rail services linking Nottingham with Grantham. This example is particularly notable because over much of their length the two types of service here duplicate each other very closely indeed. They follow parallel routes for about 18 miles while trains at about hourly intervals stop at most of the intermediate settlements served by the bus. The railway provides the faster and more frequent service. The fact that fares on buses between Grantham and Nottingham are far cheaper than on any bus service entering the city (see Fig. 5) seems therefore to indicate further competition.

Conclusion.

The findings of this case study are supported by the evidence revealed by similar studies of Derby and Leicester. In a wider field they correlate too with the evidence and conclusions presented by the Report on the Licensing of Road Passenger Services in the country as a whole.

(1) As between Nottingham and Newark the bus service linking Nottingham with Leicester takes a quite different route from the railway and cannot, therefore, compete for intermediate traffic.

Hence, despite the smallness of scale of the foregoing study some general conclusions appear to be permissible.

The large measure of success achieved in fulfilling the aims of the 1930 Road Traffic Act seems to substantiate the validity of using bus service frequency to define urban fields. The adequacy of using bus services as an index of this kind depends on two factors, namely, (1) the degree to which bus services correlate with demand and (2) the extent to which they are the most representative form of local passenger transport. There is little doubt that the 1930 Act has virtually stifled wasteful competition between bus service operators while fostering the growth of regional company monopolies. At the same time, responsibility for the introduction of services has been left with the operator and where a new service is justified by growth in demand the approval of the Licensing Authorities is readily obtained. The stimulus of initiative has therefore not been eliminated, but the possibility of anomalies arising in road passenger transport, as they might easily have done under either free competition or unregulated monopoly,(1) has been largely removed. By protecting the responsible operator and giving road passenger transport the status of a public service, the 1930 Act has also fostered the provision of necessary services on unremunerative routes. The relationship between bus services and demand has in consequence almost certainly become closer as a result of the Act than would have been possible within an unregulated framework of road passenger transport.

By failing on the other hand, to curtail competition between road and rail services the Act has permitted the bus service operator to gain almost a monopoly of local traffic. Bus services have not been prevented from taking full advantage of their greater flexibility and lower operating costs to capture short distance traffic from the railways even where frequent stopping trains are available.(2) Thus, it may be concluded that the application of the Road Traffic Act has enhanced the value of using bus service data to define and investigate urban fields. Suggestions have been made that hinterlands defined in this way must be interpreted with caution and are of limited use because they present no more than a synoptic picture.(3) Perhaps the large measure of stability accomplished in road passenger transport partially repudiates this fear.

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(1) Before the 1930 Act, unrestricted competition commonly brought overduplication of services on profitable routes while unremunerative routes were being ignored. Timetables were often haphazard and the efforts of responsible operators to provide reliable services were hindered by cut-throat competitors. The unregulated growth of monopoly by normal economic processes might easily have led to a similar neglect of responsibility.

(2) Local rail services between Derby and Nottingham were recently improved by the introduction of diesel trains stopping at most intermediate stations. Companies operating bus services between the two cities consequently appealed to the Licensing Authority for permission to introduce a new limited stop bus service to counterbalance the improved rail facilities. Permission was granted despite the fact that wasteful competition would obviously ensue.

(3) See for example the discussion following F. H. W. Green's paper : "Urban Hinterlands in England and Wales", *Geog. Journ.*, Vol. 116, September 1950, p. 81.

EAST MIDLAND RECORD

Early Geography Teaching in a Local School.

The January issue of the Bulletin of the Institute of Education (University of Nottingham) contains an interesting account by Mr. D. W. Wing of the growth of a local school, with illuminating references to the early teaching of Geography. These references are redolent of the general attitude of educationists to the subject in the second half of the nineteenth century. The British School at Arnold was promoted by donations from the Nonconformist community as a rival institution to the National School founded by the Church of England Authorities in 1860. The school was opened in 1868 with Antony Higginbottom as master and a young lady pupil-teacher to assist him. Higginbottom, whose log-books provide a valuable record of the school's progress, remained in charge until his death in 1895. At first instruction was limited to reading, writing, and arithmetic, together with Bible reading, singing and sewing for the girls. The teaching of Geography appears to have been introduced in 1874, for in that year two pupil-teachers gave lessons before a visiting inspector on British Possessions in North America and on Holland and Belgium respectively. History is first mentioned in the following year. It is doubtful however if Geography was taught for its intrinsic value ; it was certainly not taught as we know the subject today. Higginbottom wrote : "I find this subject requires drill, drill, drill to get it well done....depending to a large extent upon the memories of the children, as there are a large number of proper names (mountains, lakes, rivers, seas, towns, etc.) not previously known at all to any of them." It was currently held moreover that some subjects more than others aided children's mental development. That Geography was regarded as one of these is indicated by an entry in the log-book for 1878 : "Geography as a subject of instruction is calculated to cultivate the memory and, when maps are well used, will improve the powers of locality." If however the last phrase really refers to a sense of location, this view had a redeeming aspect. A definite change in attitude however can be detected towards the end of Higginbottoms' career, for in 1893 an article by the Secretary for Education, a copy of which was carefully preserved in the log-book, advocates less formal methods of teaching and the use of visual aids. Not many years afterwards Higginbottom's successor recorded in his log for 1901 : "Yesterday afternoon I sent the First Standard up the fields towards Mapperley Plains for an *al fresco* Geography lesson. I have questioned them this morning and judging from the answers I received and the report of the teachers in charge, the experiment was successful." With this early attempt at field work, doubtless strengthened by the stimulus of discovery through observation, the school at Arnold played its part in initiating the modern approach to Geography.—K.C.E.

Lincolnshire Geography

The Lincolnshire Architectural and Archaeological Society's Report and Papers, Vol. 7 Part II (1957-58) contains a bibliography of post-war work relating to the geography of the county compiled by Mr. D. R. Mills. More than a hundred references are given, suitably classified, and all students and teachers interested in the study of Lincolnshire will

be grateful to Mr. Mills for providing this comprehensive list. A limited number of reprints are available from the Society's secretary, Mrs. D. Owen, Flat 4, 24 East Heath Road, London, N.W.3, price 2s. 9d. post free.

The Lace Industry

Mr. D. E. Varley's book on the lace industry referred to in the article "Some aspects of the location of hosiery and lace manufacture in Great Britain", East Midland Geographer, No. 9, June 1958, has now been published by Lace Productions (1948) Ltd., Long Eaton, under the title *A History of the Midland Counties Lace Manufacturers' Association*, price 25s. The book contains a large section of considerable geographical interest.